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Curriculum Guideline

Science

Intermediate and
Senior Divisions

1986

Part 8 : Environmental Science

Grade 10, 12, Advanced Level

Post Validation Draft
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The Ontario Institute
for Studies in Education

Toronto, Canada

Advanced-Level Environmental Science

Introduction

Units of Study

The following charts provide an overview of the units of study in Grades 10 and 12 environmental science at the advanced level and indicate the time to be allocated to each unit.

Environmental Science, Grade 10, Advanced Level (SEN 2A)

Units	Time Allocations		Page
Core			
1. The Natural Environment		15 h	
2. Energy Systems		15 h	
3. A Terrestial Ecosystem Study		16 h	
4. Population Ecology		16 h	
		62 h	
Optional			
Three of			
1. Introduction to Soil Science	16 h		
2. Plant and Animal Reproduction	16 h		
3. Essentials of Plant Science	16 h		
4. Animals as Food Converters	16 h		
5. Microbiology	16 h	48 h	
6. Forestry	16 h		
7. Outdoor (Survival) Skills	16 h		
8. Locally Designed Unit	16 h		
		110 h	

Environmental Science, Grade 12, Advanced Level (SEN 4A)

Units	Time Allocations		Page
Core			
1. Energy Resources		16 h	
2. An Aquatic Ecosystem Study		16 h	
3. Environmental Quality: Water		18 h	
4. Environmental Quality: Air		12 h	
		62 h	
Optional			
Three of			
1. Applied Genetics	16 h		
2. Environmental Health Hazards	16 h		
3. Soils: An Essential Resource	16 h	48 h	
4. Fish and Wildlife Conservation	16 h		
5. Pests and Pest Control	16 h		
6. Plants, People, and Environmental Modification	16 h		
7. Outdoor (Survival) Skills	16 h		
8. Locally Designed Unit	16 h		
		110 h	

Special Features of the Advanced-Level Environmental Science Courses

1. The grade 10, advanced-level environmental science course builds on the life science units in the grade 9, advanced-level science course. Teachers should be familiar with these units and related units in other science courses so that the environmental science courses may be designed to complement the student's total science program.

2. The core units in these two courses emphasize basic ecological principles that form the foundation for an understanding of interactions in the environment. These principles can be applied to natural ecosystems, to industries such as agriculture and forestry, and to problems related to contamination of the environment. The choice of optional units permits the teacher to design an environmental science program with a particular curriculum emphasis.

3. If the grade 12 course is the only advanced-level environmental science course offered in a school the three required optional units may be selected from those listed for the grade 12 course or from the core and optional units listed for the grade 10, advanced-level environmental science course. The selection of units from the grade 10 course should be such as to provide the appropriate background for the grade 12 course and to complement the other units chosen for this course.

4. Appropriate field studies are an integral part of any environmental science course. Often the objectives of the units of study can be met by using the school property or a location near the school that

does not require an extended field trip. However at least one extended field trip is highly recommended to accomplish the objectives of these courses. Decisions regarding factors such as appropriate learning outcomes, transportation, safety, meals, and assignment of tasks should be planned for well in advance of any outdoor excursion.

5. Environmental science courses can be enriched through the use of a wide variety of resources. The teacher of environmental science should involve the teacher librarian in the planning of these courses so that appropriate materials are available and that students have the necessary research skills to use the resources effectively.

Environmental Science, Grade 10, Advanced Level (SEN 2A)

Core Unit 1: The Natural Environment Time: 15 h

The natural environment is sustained through a complex set of interactions among the living and the non-living components. In order that students may appreciate the significant role that humans play in the environment, and the widespread effects that humans have on it, they must first have a basic understanding of these interactions. This unit focuses on the basic interactions and cycles that are part of any ecosystem.

This unit may be divided into topics such as the following:

- Components of the environment
- Ecological roles of organisms
- Food chains and food webs
- Photosynthesis and cellular respiration
- Matter cycles
- Role of decomposers
- Pyramids of numbers, mass, and energy
- Interactions within an ecosystem

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the complexity of the physical, chemical and biological interactions that occur in the environment (3c, 4c);

b) curiosity about the role that organisms fill in the environment (3c, 3d);

c) an appreciation for the dependence of humans on the environment (3a, 4a-4c);

d) an appreciation for the significance of matter cycles in any sustained ecosystem (3d, 4c);

e) an appreciation of the biosphere's complete dependence on the sun as its sole source of energy, and the significance of the photosynthetic reactions in capturing this energy.

Skills. Students will have the opportunity to develop skill in:

a) observing and classifying the biotic and abiotic components of an ecosystem (2a);

b) conducting a field study to investigate the interactions in an ecosystem (2a);

c) designing and conducting experiments to investigate the role of organisms in an ecosystem (2c, 2d);

d) recording data and reporting on the results of a field study (2a).

Knowledge. Students will be expected to:

a) list various items in an environment and classify them as living (biotic) or non-living (abiotic) (2a, 2b);

b) name and describe the role of various organisms such as producers, consumers, herbivores, carnivores, omnivores, parasites, scavengers, and decomposers (2a, 2b);

c) describe typical food chains and food webs found in a natural environment (2b);

d) describe the transfer and transformation of energy in a food chain;

e) describe the flow of matter through a food chain;

f) briefly describe the photosynthesis - respiration cycle in a schematic diagram;

g) describe the significance of the cyclic process of cellular respiration and photosynthesis;

h) distinguish between the recycling of matter and the one-way flow of energy in the photosynthesis - respiration cycle (2c);

i) construct schematic diagrams to depict other matter cycles such as the carbon cycle, water cycle, and nitrogen cycle;

j) recognize the significance of soil organisms in the natural environment, and describe the role they play in many matter cycles (2d);

k) construct pyramids of numbers, mass, and energy for several food chains (2b);

l) give examples of the interactions between the biotic and abiotic components in an ecosystem.

2. Student Activities

Students are to:

*a) conduct a field study of an ecosystem such as a pond, stream, field or urban region, identifying the biotic and abiotic components and describing the interactions that exist (6a, 6b, 8a);

b) observe a film, video, or set of slides showing a wide variety of organisms in the natural environment, and record the roles of these organisms in the environment;

c) conduct an experiment to observe the release of heat energy from seeds undergoing respiration (e.g., seeds germinating in a vacuum bottle);

d) conduct an experiment to investigate the role of soil organisms in decomposing organic matter (e.g., a small sample of paper buried in loam soil over a long period of time).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Short food chains make more efficient use of matter and energy. For this reason in overpopulated countries humans tend to feed directly on plant crops rather than on agricultural animals that have been fed crops.

b) In order that a species may survive its environment or ecological habitat must be preserved. Parks and sancturaries are established for this purpose.

c) Bacteria are useful organisms in many matter cycles (e.g., bacteria are used in the treatment of sewage).

d) Agricultural practices can deplete the soil. Matter cycles involving animal and green manure may be used to improve and replenish the soil.

4. Societal Implications

a) The natural environment provides a model which humans can utilize to design urban and rural environments which are both healthy and sustainable.

b) The environment has a fixed carrying capacity and is capable of supporting a limited number of organisms.

c) In order that humans may develop healthy and sustainable environments, matter must be recycled and resources must be renewed (e.g., the recycling of animal and green manure on agriculture land, reforestation and the recycling of metals in items such as cans and automobiles).

5. Evaluation and Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) observations and classifications of biotic and abiotic features in an outdoor environment;

b) ability to design an experiment to test a hypothesis;

c) ability to control variables in an experiment;

d) ability to make conclusions from data collected in an experiment, or field study.

6. Safety Considerations

a) Animals observed during field studies should be treated with caution.

b) Students should be warned that some plants found on the site of field studies may be poisonous.

c) Appropriate guidelines should be established and followed during a field study.

7. Possible Extensions

Some students might:

a) investigate the effect of an abiotic factor such as temperature or light on the growth or behaviour of an organism;

b) construct a closed, balanced ecosystem (e.g., an aquarium or terrarium);

c) conduct an experiment to study respiration in simple organisms.

8. Some Teaching Suggestions

a) A field study is necessary to meet the objectives of this unit. The study can be done using the school yard, a vacant lot, local park, or other easily accessible location. It is not necessary to complete an extended field trip to meet the objectives of this unit.

b) Students should be encouraged to use all their senses while observing the environment during a field study.

c) The evaluation of students' laboratory and field work can focus on one mark for organization and communication of information and a second mark for analysis and interpretation of the data.

d) Sources of suitable plant and animal material for classroom investigation must be obtained ahead of time.

e) This unit should be planned to avoid duplication with core unit 1: "Interaction" in the grade 10, advanced-level science course.

Core Unit 2: Energy Systems

Time: 15 h

The energy consumption by living organisms tends to be one-way just as it is in food chains. Since traditional fuels are finite in supply energy sources must be used wisely. Consideration must be given to both natural and manufactured energy systems and the inefficiencies and pollution for every energy conversion making up these systems.

This unit may be divided into topics such as the following:

- Natural energy systems
- Human-designed energy systems
- Energy conversions and efficiencies
- Non-renewable and renewable energy sources
- Environmental impact of energy consumption

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the dependence on energy for our survival (4a);

b) a questioning attitude concerning our dependence on non-renewable energy (3d, 4a, 4b);

c) curiosty about the benefits of developing renewable energy forms (3d, 4c);

d) a commitment to consider changes in their own lifestyle which would lead to energy conservation (3e, 4c).

Skills. Students will have the opportunity to develop skill in:

a) classifying various forms of energy;
b) calculating efficiencies of energy conversions (2b, 8e);
c) using a systems approach to analysing energy conversions (2b);
d) measuring and recording energy consumption at home/or school (2f);
e) reading electrical and/or natural gas meters (2e, 2f);
f) interpreting information given on energy bills (2f);
g) predicting where energy might be conserved in their daily routine (2f, 8c).

Knowledge. Students will be expected to:

a) describe the concept of a system (2b, 8b);
b) describe the components of the energy flow system in an ecosystem (2a);
c) outline the reasons for energy loss at each step in the energy flow system in an ecosystem (2a, 8b);
d) apply the law of conservation of energy to an ecosystem and describe its significance (2a);
e) recall the energy systems in photosynthesis and cellular respiration and describe their interdependence;
f) calculate the net energy efficiency of various energy conversions from both natural and human-designed systems (2b, 8e);
g) describe one energy system which exists in the home and/or school (2b);
h) name non-renewable and renewable sources of energy (2d);
i) summarize the environmental impact from using various nonrenewable energy sources;

j) list the considerations such as availability and cost involved in choosing a home energy source (2b);

k) rank Canada with other nations with respect to total energy consumption per capita per year;

l) describe lifestyles which are less wasteful of energy.

2. Student Activities

Students are to:

*a) write a report on the flow of energy through an ecosystem including a consideration of a pyramid of energy for a given food chain and the calculations showing the percent energy bound at each level of the pyramid, given actual energy values for that pyramid (8b);

*b) write a report on the energy conversions in a human-designed system, such as a home appliance, pulp and paper mill, or the procedure for planting and harvesting crops, and calculate the net efficiency of the energy conversions (8e);

c) design and conduct an experiment to find ways of extracting bitumen from a tar sands sample (6d);

d) investigate the nature of renewable energy by activities such as constructing and using a solar cooker, measuring the performance of a solar panel, or measuring the electrical output of a solar cell;

e) determine the amount of electricity or natural gas used in a building over a period of time by reading the appropriate meter;

f) record the energy consumption of as many energy converters as possible in the home and/or in the school and calculate the total energy consumed (6a-6c, 8d, 8f, 8g).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Industries are involved in reviewing their processing systems and are making changes to minimize energy use and cut long-term production costs.

b) Many large office buildings and schools have an energy management team to oversee a comprehensive energy conservation program.

c) Houses are retrofitted by such actions as weatherstripping, caulking, and insulating, in an attempt to reduce heat loss in winter and heat gain in summer.

d) New industries have grown out of the research and development for renewable energy forms.

e) An understanding of energy systems and conservation makes it possible to save energy and money in the home.

4. Societal Implications

a) North American dependence on foreign oil has had a major economic consequence.

b) Governments have a role to play in making Canada less dependent on non renewable fuels.

c) As the world supplies of non renewable fuels decreases, energy consumers will be forced to modify their lifestyles. At the same time, the development of renewable sources will become much more attractive.

d) Over insulation of a building may cause health problems by decreasing the flow of fresh air into the building.

e) A risk-benefit analysis needs to be done when developing new energy conservation methods (e.g., the use of urea-formaldehyde foam insulation).

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) calculations to show the net efficiency of a series of energy conversions;

b) measurements and records of energy consumption in a building;

c) reports on the energy flow in a system.

6. Safety Considerations

a) Wires near electric meters or appliances should not be touched.

b) Electrical appliances should be disconnected before searching for an information plate.

c) The school's custodial staff should be consulted and students should be supervised when reading energy meters at the school.

d) Safety goggles and aprons should be worn when heating a tar sands sample. Open flames should not be used directly on the sample.

7. Possible Extensions

Some students might:

a) prepare a report on the advantages and disadvantages of nuclear-generated electricity;

b) compare the cost of heating a home with oil, natural gas, electricity, wood or solar energy;

c) compare the energy systems of throw-away versus returnable containers;

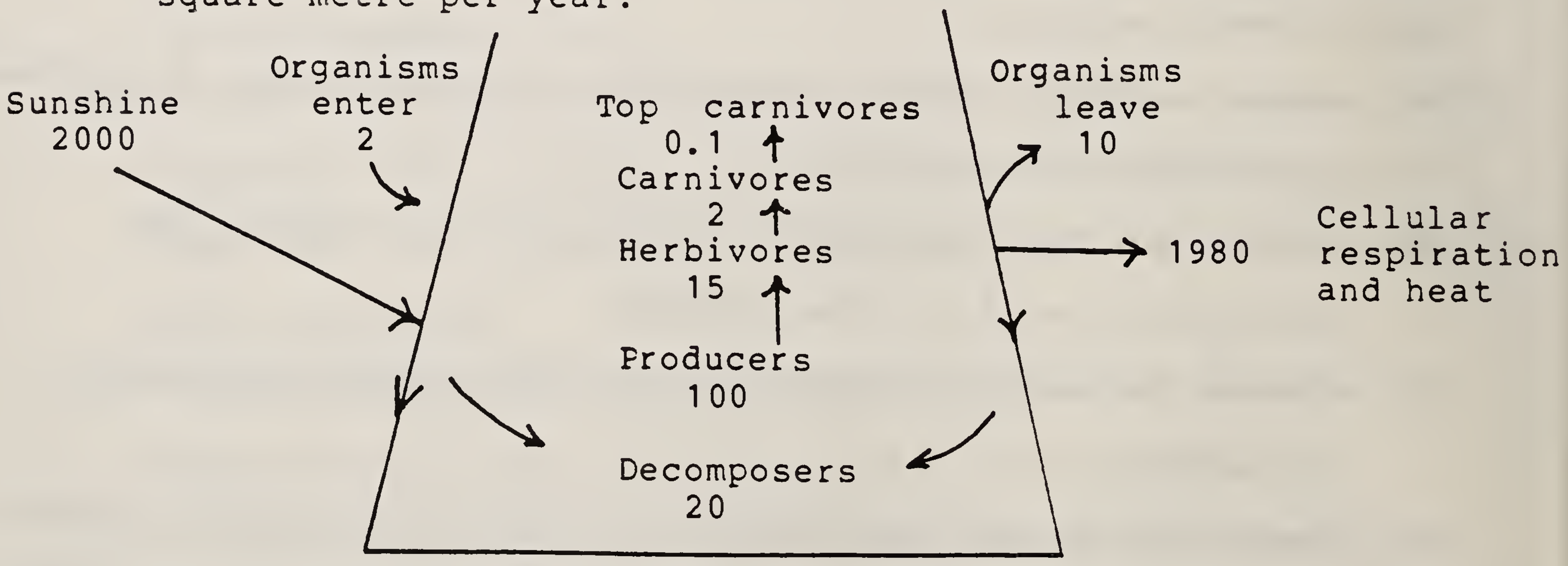
d) compare the energy consumption of a family using cloth diapers for their baby to one using disposable diapers over a two year period;

e) prepare a report for the school principal concerning the need for an energy awareness program in the school.

8. Some Teaching Suggestions

a) The systems approach to analysing energy flow should be the focus of this unit. It is no longer adequate to look at a single energy conversion, or a single site where energy is lost. Rather, the set of events leading up to, and then following a single energy conversion should be considered. The interrelationships of the various components of the system should be emphasized. One small change in the system may have a significatn impact on the whole system. An energy system which can be considered is the one involved with heating a home with oil. The steps in this system would include drilling for the oil, pumping, refining, shipping, storage, transport to the home, burning the fuel for space heating, and loss of waste heat to the environment.

b) An energy system such as the following can be developed from an energy pyramid. Numbers given are approximate megajoules per square metre per year:



c) A guest speaker can be invited to talk on a topic such as energy management, energy efficient driving habits, or food conversions.

d) Data can be collected to compare the energy consumption in a house with that in an apartment. Assistance may be needed in collecting the data for apartments. This data can be organized in a chart such as the one below:

Device	Power Rating (watts)	Time used (hours/month)	Estimated consumption (kilowatt hours per month)
Light	60	100	6

In a follow-up session the role of people and pets as energy users in the home energy system can be discussed.

e) When calculating net energy efficiency of a system, multiply the individual efficiencies are multiplied together. The net efficiency of an incandescent light bulb can be determined as follows:

$$\underset{\text{(coal generating station)}}{33\%} \times \underset{\text{(transmission lines)}}{95\%} \times \underset{\text{(light bulb)}}{4\%} = 1\%$$

Or to run an electric heater from electricity generated from solar cells:

$$\underset{\text{(solar cell)}}{14\%} \times \underset{\text{(electric heater)}}{98\%} = 13.7\%$$

f) School energy records dating back several years may be available from the school custodial staff or from the administration offices of the school board.

g) With adequate notice, the custodian may show the class the boiler room, fan room, and various meters and lighting controls at the school.

Core Unit 3: Terrestrial Ecosystem Study Time: 16 h

The study of a selected ecosystem provides the opportunity for students to bring together concepts developed in previous units, and to apply them to a specific example. It also permits students to develop an appreciation for these natural environments. Students should recognize that the ecological principles observed in a small ecosystem also operate in the large biomes distributed across Canada.

This unit may be divided into topics such as the following:

- Abiotic characteristics
- Soil characteristics
- Species in the ecosystem
- Population estimates
- Interrelationships

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the complexity of most ecosystems (2a, 4a);

b) an appreciation for the delicate balance and sensitivity of an ecosystem (2a, 3d, 4a);

c) a respect for all living things (2a, 3b, 3d, 4a);

d) an awareness of the ways that ecosystems can be affected by human activities (2a, 3d, 4a, 4c).

Skills. Students will have the opportunity to develop skill in:

a) measuring the abiotic factors of an ecosystem, such as temperature, relative humidity, light intensity, light duration, wind velocity, and precipitation (2a);

b) conducting experiments to determine various soil characteristics, such as soil particle size, percent organic matter content, water holding capacity, percolation rate, and chemical element content (2d);

c) using field guides, keys, and other material from the library resource centre to identify the various organisms in an ecosystem (2a);

d) estimating populations of organisms in an ecosystem (2a);

e) constructing graphs to show the relationship between variables such as temperature and relative humidity, light intensity and species population, and soil pH and plant species populations (2a).

Knowledge. Students will be expected to:

a) describe the abiotic characteristics of the selected ecosystem, such as temperature, humidity, wind, light intensity, light duration, and precipitation (2a);

b) describe the interrelationships between the various abiotic factors of the selected ecosystem, such as:
    (i) the effect of temperature on relative humidity,
    (ii) the effect of wind on relative humidity,
    (iii) the effect of altitude (10 cm vs 200 cm) on relative humidity;

c) describe soil characteristics such as mineral content, mineral particle types, organic matter content, water holding capacity, percolation rate, and fertility for the selected ecosystem (2d);

d) explain the concept of succession and relate this to the plants and animals, including soil organisms, found in the selected ecosystem (2a, 2d);

e) compare the populations of the various organisms in the selected ecosystem (2a);

f) recall the types of interactions between living organisms that exist in an ecosystem and relate these to the selected ecosystem (2a);

g) describe the interrelationships between some of the biotic and abiotic components of the ecosystem, such as (i) plant species and available light, (ii) plant populations (of one species) and available light, (iii) animal species and humidity, (iv) plant species and soil characteristics, (v) animal species and temperature, (vi) insect species and altitude (10 cm vs 200 cm) (2a-2c).

2. Student Activities

Students are to:

*a) visit a local park or other area to observe, measure, compare, and analyse the many and various components of an ecosystem as follows:

   (i) measure the temperature, humidity, wind, light, and precipitation at various locations in the ecosystem (e.g., at various altitudes - ground level, 10 cm above ground level, 100 cm above ground level, in open areas versus areas with dense vegetation);

   (ii) use field guides, keys, and other resources to identify the various organisms in the ecosystem;

(iii) estimate the populations of different species of plants and animals;

(iv) use the data collected from the ecosystem to construct appropriate food chains, food webs, and pyramids of numbers, energy, and mass;

(v) construct graphs to compare the various components of the ecosystem and determine the relationships between such factors as temperature and humidity, light intensity and population of a plant species, humidity and population of an insect species (6);

b) conduct an experiment to determine the effect of factors such as temperature, light intensity, soil type, or humidity on the growth of one species of plant;

c) conduct an experiment to determine the effect of light direction on the growth of one species of plant;

d) analyse a sample of soil from the ecosystem to determine pH, soil particle size, percent organic matter, water holding capacity, percolation rate, fertility as indicated by the presence of chemical elements, types of organisms present, and the species of plants that grow on different types of soil.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Unique ecosystems may be identified and preserved as parks for posterity.

b) Natural ecosystems may serve as a gene pool for specific plant and animal species, which may be useful in the future to improve plant crops and animal livestock.

c) An inventory of species found in ecosystems is useful to determine the status of endangered species in Canada and North America.

d) A knowledge of the normal interactions in an ecosystem can be used as a basis for determining the effect of human activities on the ecosystem.

4. Societal Implications

a) Human activities often alter the natural balance of ecosystems, sometimes causing some species to become extinct and others to reproduce too rapidly.

b) Some ecosystems may be safely used as recreational areas for humans.

c) Humans are part of most ecosystems and must be considered as one of the biotic components of the ecosystem.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) records of field observations;

b) records of measurements of abiotic factors;

c) identifications of plants and animals in an ecosystem;

d) graphs to compare the various components in an ecosystem.

6. Safety Considerations

a) Animals observed during the field study should be treated with caution. Insects in some ecosystems may cause irritating bites or painful stings.

b) Students should be cautioned about the plants in the selected ecosystems which may be poisonous to eat or touch.

c) Appropriate guidelines should be established and followed during a field study.

7. Possible Extensions

Some students might:

a) construct maps of the ecosystem area based on such features as vegetation, soil profiles, or elevation;

b) investigate the ecosystem area for evidence of succession;

c) design and conduct experiments to determine the effect of physical factors on living organisms (e.g., respiration rate vs temperature, photosynthesis rate vs temperature, transpiration rate vs temperature);

d) construct a terrarium to study a food chain;

e) use the library to research a Canadian biome and compare and contrast it with the ecosystem studied.

8. Some Teaching Suggestions

a) This unit follows logically from core unit 1, "The Natural Environment". An opportunity is provided in this unit to do an in depth study of a selected ecosystem.

b) The area to be studied should be visited in advance to determine the potential of the study area as well as possible safety hazards.

c) Students should be encouraged to cooperate in team projects as well as to work independently on individualized activities during field studies.

d) In each student group tasks should be assigned (e.g., group leader and recorder).

e) When estimating population the mark and release technique is best used with insects such as grasshoppers. The scat technique can be used for small animals.

f) The ecosystem may be selected from the school property or a local ravine if a full-day field trip is not feasible.

g) Equipment used to monitor abiotic factors may be inexpensively manufactured at home or in the school technical shops.

h) This unit should be planned to avoid duplication with core unit 1, "Interactions", in the grade 10, advanced-level science course.

Core Unit 4: Population Ecology Time: 16 h

Interactions within natural ecosystems regulate population levels of all species. Generally, the total population of each species, as well as the ratio between populations, fluctuate within certain limits. These system interactions must be understood before the natural condition of an ecosystem is disturbed. This unit gives the student an introduction to population ecology.

This unit may be divided into topics such as the following:

- Species and populations
- Population density
- Biotic potential
- Environmental factors
- Carrying capacity of a natural ecosystem
- Population cycles in a natural ecosystem

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for the natural checks and balances which control population sizes effectively in an ecosystem (2d-2f, 3c, 4a);

b) a commitment to use the principles of population ecology to successfully co-exist with other organisms.

Skills. Students will have the opportunity to develop skills in:

a) plotting a population growth curve (2d);

b) culturing living organisms to conduct a population study (2a, 2c);

c) counting live organisms using appropriate techniques, for example, quadrat sampling using the microscope to count live yeast cells (2a, 2c).

Knowledge. Students will be expected to:

a) define and give one example for the terms: species, population, population density, biotic potential, environmental resistance, carrying capacity (2b);
b) explain the factors which influence natality and mortality rates and immigration and emigration rates (2d);
c) explain how community relationships such as commensalism, mutualism, parasitism, and predation affect species population;
d) list environmental factors which influence population size (2d-2f);
e) interpret a sigmoid growth curve in relation to a given population (2c);
f) describe at least two population cycles in a natural ecosystem and state the factors which are most prominent in controlling those cycles;
g) explain how carrying capacity for one species can vary from one ecosystem to another;
h) define the term zero population growth and explain its significance in terms of the human population;
i) compare natality and mortality rates for humans between the last century and this century and suggest possible factors influencing the rate difference.

2. Student Activities

Students are to:

*a) set up a closed ecosystem as a class exercise at the beginning of the unit, then follow the population growth of at least one species for over the next two or three weeks (e.g., daphnia);

b) plan a field trip to a near-by field or park to study population density of one or more species including the following: measure the area concerned and count all individuals in that population (the quadrat method may be used as an alternative to determine the number of individuals of a given species), mark the location of each individual on a map of the area to be used for density calculations in the classroom (6);

c) establish cultures of organism such as yeast or fruit flies which have various ages and compare the population count in each culture (8a, 8b);

*d) plot a growth curve on both regular and semi-log graph paper, given the birth and mortality rates for a hypothetical population, and compare the curves giving reasons why this growth rate would rarely occur in real-life situations despite the biotic potential of the species concerned. A bird population on an island with no natural predators can be used as the example (8c);

e) design and carry out an experiment to study the effect of available nutrients on growth rate (e.g., growth of algae in solutions with various nitrate concentrations);

f) examine a map or photographs showing Canadian biomes and determine how climate affects population growth (e.g., maple trees are found only in certain biomes according to climate);

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Population studies are essential in the science of genetics.

b) Modern farming practices show the results of research into increasing the population density of crops and determining the maximum carrying capacity of an area to prevent over use.

c) Some wildlife populations have been severely reduced by humans and as a result hunting seasons are strictly regulated.

d) Pollution of lakes has resulted in the decrease of some fish populations.

4. Societal Implications

a) Extinction of an organism may occur if its population size decreases below a critical number.

b) It has been found that natality rates are significantly lower in many artificial breeding situations (e.g., zoos may not be the answer for preserving endangered populations).

c) One method of controlling pests is to bring a natural predator for that pest into the area. This method can produce negative results as the entire ecosystem is disrupted.

d) World human population growth is limited by the resources of the biosphere. These resources need to be managed wisely.

e) Population studies that illustrate global trends may be useful in coping with world food demands and in directing the development of technologies to deal with the problems.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) plots of population curves on regular and semi-log paper;

b) ability to determine the size of a population in a culture.

6. Safety Suggestions

Appropriate guidelines should be established and followed during a field study.

7. Possible Extensions

Some students might:

a) set up a colony of fruit flies or other organism and follow its population size over a period of time;

b) prepare a report for discussion or debate on what makes an "acceptable" standard of living for humans;

c) analyse the factors involved in the extinction of a particular population.

8. Some Teaching Suggestions

a) If yeast cultures are used for population studies two approaches are possible. The first method involves inoculating the first test tube on day one, the second on day two, and so on for eight or ten consecutive days. The second method involves inoculating a single test tube on the first day and taking one drop samples to count the populations on 8 or 10 consecutive days. Students can make several counts for each sample and average the results.

b) Alternate organisms for population studies can include fruit flies, duck weed, or algae.

c) The use of semi-log paper does not necessitate a lesson on logarithms. It is used as a tool to show students how much easier it allows the plotting of an exponential curve.

d) Many case studies are available on the extinction of species, and on endangered species.

e) This unit should be planned to avoid duplication with core unit 1, "Interactions", in the grade 10, advanced-level science course.

Optional Unit 1: Introduction to Soil Science Time: 16 h

Soil is the usual medium for the growth of terrestrial plant life. Very quickly it can be lost from use and natural replacement is a slow process. This unit provides an introduction to the properties of soil that should be of practical value in the indoor and outdoor culture of plants, and in wise decision making as to possible land uses.

This unit may be divided into topics such as the following:

- Role of soils
- Soil formation processes
- Composition of a soil
- Soil texture
- Soil water types
- Plant nutrients
- Soil erosion
- Soil organisms

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that soil is a a complex system containing a variety of interacting biotic and abiotic factors (4d);

b) a respect for soil formation as being a slow process in nature (4c);

c) an appreciation for the importance of soils in food and forest production (4a);

d) an appreciation of the need to conserve good agricultural soils (4b).

Skills. Students will have the opportunity to develop skill in:

a) observing and recording the properties of soil (2b-2e, 2g);

b) using volumetric and mass determination equipment to determine the percentage of solid material in soil (2b);

c) classifying soils according to texture (2d);

d) experimenting to determine the amount of water in a soil (2e);

e) identifying living organisms found in soil (2g).

Knowledge. Students will be expected to:

a) explain the role of soil as a medium to anchor plants and as a reserve for needed plant nutrients;

b) explain the process of soil formation from soil parent material;

c) identify the main characteristics of the major horizons of a soil profile;

d) express the percentage composition by volume of a loam soil type as to mineral, organic matter, air, and water content;

e) explain suitable demonstrations or experiments to illustrate plant nutrient storage, soil composition, and soil moisture levels (2b, 2d, 2e);

f) interpret from graphs the effect of soil pH on nutrient availability (2c);

g) state the types of soil water and explain the nature of gravitational, capillary, hygroscopic, and chemically bound water (2e);

h) explain the processes of soil detachment and transportation involved in soil erosion;

i) using a soil texture triangle, explain the limits of a soil texture type (2d);

j) name and suggest the role of many of the biotic factors in a soil ecosystem;

k) list the macronutrients and micronutrients required by plants;

l) explain the major roles of nitrogen, phosphorus, potassium, and calcium in plant nutrition;

m) identify several practices that affect the erosion of soils (2f);

n) name and describe several practices to limit soil erosion (2f).

2. Student Activities

Students are to:

a) observe and describe the main characteristics of the major horizons of a soil profile;

*b) determine the percentage by volume of solid material in a soil using the addition of water to an oven dried sample and the percentage by mass of organic matter and mineral in a soil by burning out the organic matter (6a);

c) determine the soil pH by wetting the soil and testing the sample with a suitable pH indicator;

*d) compare several soil samples with respect to texture and percentage of sand, silt, and clay;

*e) determine the amounts of some types of soil water in a soil by adding water to an oven dry soil until saturated, draining the water from a saturated soil sample overnight to field capacity (to determine gravitational water loss), culturing a plant without watering from field capacity until the permanent wilting point is reached (to determine capillary water content), and drying a soil from the permanent wilting point to the air dry level (to determine hygroscopic water content);

f) determine the effect of soil texture on water holding capacity and percolation rates;

g) separate out and examine various soil macroorganisms such as earthworms, nematodes, arthropods, and use soil to inoculate suitable media for the culture of soil micro-organisms such as fungi or algae) (6b).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) A change in soil pH because of acid or lime additions influences nutrient availability which can have a very noticeable effect on plant growth.

b) Macronutrients, especially nitrogen, phosphorus, and potassium, are the major ones requiring replenishment for plant culture in such areas as home gardens and field crops.

c) An understanding of soil texture can be used to improve soil types (e.g., the addition of sand to fine textured soils such as clays or clay loam).

d) Percolation rates for soils are important in determining watering or irrigation rates.

e) Soil texture has a great influence on crop or plant selections, resistance to drought, and the time interval required before a soil can be cultivated following a rain.

4. Societal Implications

a) Soils are a major resource that are used for the production of plants for food, fibre, energy production, and for aesthetic value.

b) Good agricultural soils are being lost in areas of rapid urban development.

c) Soil replenishment by natural soil-forming processes is achieved slowly, underlying the need for soil-conservation practices.

d) Soil as a living system decomposes and recycles matter preventing the accumulation of organic wastes.

e) The harvesting of plant crops removes mineral nutrients that are not easily replenished.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) observations and records of the physical and biological properties of soils;

b) measurements and calculations to determine the percentage of various soil components;

c) laboratory reports outlining an experiment to determine the properties of soils;

6. Safety Considerations

a) Soil samples should be heated in a ventilated room.

b) Cultures of soil microorganisms should be destroyed with a strong alkali before disposal.

7. Possible Extensions

Some students might:

a) investigate the roles of various micronutrients in plant nutrition;

b) investigate the soil texture and pH requirements for specific crops;

c) investigate modern methods of field determination of soil water levels;

d) collect and analyse data on local soil conservation practices;

e) examine a variety of fertilizers to determine the phosphorus, potassium, and nitrogen content, and relate these nutrient levels to the suitability for different plant species.

8. Some Teaching Suggestions

a) Several soil type samples should be obtained previous to teaching this unit.

b) Universal indicator added to wet soil samples on folded strips of wax paper is a good technique for determining soil pH.

c) A beaker of gravel and water can be used to quickly illustrate the four types of soil water.

d) Suitable media and equipment for the culture of soil microorganisms are available from biological supply houses. Nematode filters can be easily improvised from standard laboratory equipment and cheesecloth.

e) Potted plants such as coleus, tomato, or sunflower can be used to determine the permanent wilting point (point at which plants do not recover).

Optional Unit 2: Plant and Animal Reproduction Time: 16 h

Reproduction is necessary for the continuation of a species. It is the means of perpetuating genetic codes in future individuals. This unit introduces the main forms of reproduction (sexual and asexual). Studies will include the forms of fertilization - external and internal, and reproductive capabilities will be related to population maintenance. Studies will include an examination of how selected organisms may be managed for human needs.

This unit may be divided into topics such as the following:

- Genetic variability
- Asexual and sexual reproduction
- Life cycles
- External and internal fertilization
- Plant and animal breeding

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the great genetic variability that exists in plant and animal species;

b) a respect for the efforts and advancements of Canadians in the fields of agricultural research and management.

Skills. Students will have the opportunity to develop skill in:

a) observing small life forms such as planaria, hydra, paramecia, or amoeba (2b);

b) growing a new plant from a cutting (2d);

c) examining the floral parts of flowers to observe the sex organs used to produce sex cells (2e);

d) predicting the reproductive potential for selected species according to the environment of the organism (2c).

Knowledge. Students will be expected to:

a) describe several examples of intraspecific variation to illustrate the wide range of genetic variability;

b) define basic reproductive terms such as sex cells, fertilization, and reproductive potential (2b, 2c, 2f, 2g);

c) list selected organisms that reproduce asexually (2b);

d) contrast sexual and asexual reproduction in terms of advantages and disadvantages to the species (2b, 2c, 2g);

e) describe the life cycle of a selected moneran, fungus, and protist;

f) recognize the male and female organs used to produce sex cells in selected local species (2g);

g) compare external and internal fertilization in selected organisms and state advantages and disadvantages to the species;

h) describe the life cycle of a typical local plant and/or animal;

i) describe the use of selective mating to improve specific characteristics of a species (2b);

j) indicate methods used to manage the reproduction of domestic plants and animals;

m) compare the reproductive potential and breeding management programs for selected organisms (e.g., house-fly, earthworms, trout, pigeons, cattle).

2. Student Activities

Students are to:

a) collect information and write a short report on the various methods used by organisms to produce progeny;

*b) observe asexual reproduction in selected life forms (e.g., hydra, planarian, diatom, paramecium, amoeba);

*c) observe selected stages in the reproduction of fungi (e.g., mushroom, bread mold, wheat rust, corn smut, apple scab);

*d) grow a plant by asexual reproduction (e.g., cutting of coleus, or geranium, bulbs, tubers, rhizomes, stolons);

*e) observe and describe the reproductive structure of a fern, a pine, or a flowering plant;

f) examine and compare the structure of a self-pollinating pea flower and a cross-pollinating corn flower (6a);

g) observe and compare the reproductive system of selected local species (e.g., earthworm, insect, fish, bird, and mammal).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) The survival of fish populations is dependent upon the large number of progeny per female (e.g., 100 000 eggs per release).

b) The management of domestic animals is determined, in part, by the reproductive cycles of the species (e.g., heat periods in cows, horses, dogs, cats).

c) Selected features in progeny may be brought about by choosing the parents for planned matings.

d) Harmful fungi such as smut, scab, mold or mildew may grow and reproduce out of control given the ideal environmental conditions.

4. Societal Implications

a) The reproductive structures of wild organisms are adapted to their environment.

b) Humans have utilized the natural reproduction methods of useful organisms to selectively produce progeny with desired traits for the benefit of mankind (e.g., horse size, corn yield, milk production, or body shape in dogs).

c) Reproduction can be controlled by human manipulation of parents and their respective sex organs (e.g., separation of bulls and cows, castration, or emasculation of male corn flower).

5. Evaluation of Student Achievment

At least 40 per cent of the term mark for this unit is to be based on students':

a) laboratory work;

b) projects, assignments, and laboratory reports.

6. Safety Considerations

a) Sharp instruments used for cutting plant material should be used with care.

b) Protective eyewear and gloves should be worn if a dissection is done.

7. Possible Extensions

Some students might:

a) attempt to cross pollinate a plant and grow new plants from the resulting seed;

b) do a comparative study of organisms within a particular group to record differences in reproductive methods.

8. Some Teaching Suggestions

a) It should be stressed that reproduction is essential to perpetuate the species. The species that reproduces most successfully is more likely to survive in the long term.

b) If vertebrate animals such as gerbils or mice are used for reproductive studies the appropriate animal care guidelines must be followed.

Optional Unit 3: Essentials of Plant Science   Time: 16 h

The culture of plants requires the application of knowledge in biology, ecology, chemistry, physics, soils, and usually economics. As in all systems a weak link in the plant culture system can prevent full plant growth. This unit examines the basic factors that influence plant growth together with a study of techniques for managing these factors. This unit provides information that will enable students to grow plants and also provide them with a background for future advanced studies in botany, horticulture, forestry, or crop science.

This unit may be divided into topics such as the following:

- Requirements for plant growth
- Suitable media for plant culture
- Light
- Temperature
- Oxygen, carbon dioxide, and water vapour levels
- Water requirements
- Mineral nutrient levels
- Effect of growth regulators
- Plant modification practices

1. Objectives

Attitudes. Students will be encouraged to develop:

a) respect for plants as being complex organisms;

b) an appreciation that any kind of plant culture involves the application of scientific principles;

c) an appreciation for the close relationships between abiotic conditions and plant growth, development, and survival (2d).

Skills. Students will have the opportunity to develop skill in:

a) handling and culturing plant material;

b) measuring such abiotic factors as light intensity with a light meter and temperature with a thermometer (2c, 2d);

c) designing an experiment to illustrate the effect of temperature on rooting of softwood stem cuttings or on the germination of seeds (2c);

d) investigating the use of various media for plant culture or the effect of various plant spacings on plant growth (2a, 2b);

e) deriving and interpreting graphs involving such factors as temperature, carbon dioxide concentrations, light wavelengths, nitrogen levels, on plant growth (2c, 2i);

f) investigating plant tropisms such as geotropism or phototropism (2e);

g) modifying plant structures by pinching or hardening practices (2g);

h) using minute quantities of plant hormones to alter the development of plants (2h);

i) testing the soil nutrient levels for nitrogen, phosphorus, potassium and calcium (2j).

Knowledge. Students will be expected to:

a) list the principle requirements for plant growth and development and compare the major effects of each (2j);

b) explain the suitability of various media, including soils for plant culture (2a);

c) list the most effective colours of light for growing plants;

d) explain the effects of light intensity and photoperiodism on plants and describe how to regulate these factors (2d);

e) categorize plants as to temperature requirements (cool season, warm season) and as to life cycles (annual, biennial, perennial);

f) describe the effects on plants of various concentrations of oxygen, carbon dioxide, and water vapour (2i);

g) describe the effects of temperature and amount of heat on the growth plants (2i);

h) describe the sources of water in soils for plants, the amounts required, the methods of entry into plants, and the uses of water in plants;

i) explain how soil water supplies are recharged naturally and by irrigation practices;

j) state the usual ranges of nutrient levels for plant culture of nitrogen, phosphorus, and potassium and indicate their usual fertilizer sources (2j);

k) describe various natural methods of replenishing the soil nutrients removed by crops including mineral solution, nitrogen fixation, decomposition of organic matter, and deposition from wind and water;

l) describe fertility management practices such as fertilizer and lime applications, crop rotations, inclusion of legumes in rotations, incorporation of plant refuse or manures (2j);

m) explain the actions and interactions of some hormones in plants, such as those responsible for phototropism and geotropism, and state their effects on the plants (2e);

n) describe some basic techniques in propagating plants from seeds or cuttings, including watering, and fertilizing the plants (2a, 2c, 2g);

o) explain the effects of pinching, disbudding, and pruning on plant growth and development (2g).

2. Student Activities

Students are to:

*a) investigate the use of various media, including soils, for seed germination and plant development (6b);

b) investigate the effect of various plant spacings on plant growth and development;

*c) design and carry out an experiment to show the effect of temperature on plants growth (e.g., the rooting of softwood stem cuttings or the germination of seeds);

d) demonstrate the effect of various light intensities on plant growth and development;

*e) demonstrate geotropism or phototropism;

f) investigate the effects of high and/or low levels of nutrients on potted plants;

*g) investigate the effects of pinching, disbudding, or hardening on the development of plants;

*h) investigate the effects of hormone powders on the rooting of softwood stem cuttings (6d);

i) demonstrate the effect of increased or decreased carbon dioxide levels on the growth of potted plants;

*j) test soil samples for the relative levels of some of the major nutrients such as nitrogen, phosphorus, potassium, and calcium.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Rooting hormone powders can be applied to the cut parts of species that are hard to propagate from cuttings to aid rooting.

b) Plants may be grown hydroponically if the basic principles involved in plant culture are adhered to.

c) Forest nursery seedling are dug or lifted in the fall according to light conditions and temperatures.

d) Thinning of various vegetable plants such as beets or lettuce is necessary to allow space for proper plant development.

e) Corn is planted according to the average accumulation of heat units in the district.

4. Societal Implications

a) Plant modification by some form of pruning is often necessary to obtain the desired size and form of flowers to produce quantities of fruit commercially.

b) Soil is the most widespread medium for growing plants because of its abundance and its capacity to store mineral nutrients. Soiless media are considered by many horticulturists to be superior to soil.

c) Plant growth factors can only be partially regulated in field situations. However, in greenhouses, they may be electronically monitored and regulated by computerized equipment.

d) Plants from various parts of the world may be utilized for home and garden decoration, and for garden, field, and forest production if the proper conditions for plant growth and development can be provided.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) laboratory reports on the use of various media for seed germination;

b) ability to measure abiotic factors;

c) design of experiments to illustrate the effect of abiotic factors on plant growth;

d) ability to interpret experimental data involving abiotic and biotic factors.

6. Safety Considerations

a) Students should be cautioned that some plants may cause allergic reactions.

b) Hands should be washed after handling any soils, fertilizers, or chemicals.

c) Students should be cautioned that soluble fertilizers are mixed with dyes that will temporarily stain the hands.

d) Care should be exercised when making softwood stem cuttings with sharp knives.

7. Possible Extensions

Some students might:

a) demonstrate methods of soilless culture;

b) investigate the effects of day length on a responsive plant such as poinsettia;

c) demonstrate an absorption spectrum for extracted chlorophylls from plants;

d) demonstrate the effect of a regular fertilizing programme on the growth of relatively quick growing house plants.

8. Some Teaching Suggestions

a) A growth area or greenhouse is desirable for teaching this unit. Plans need to be made regarding growth areas well in advance of teaching this unit.

b) A variety of media, perhaps as suggested by students, such as sand, gravel, vermiculite, sawdust, manure, and compost need to be acquired for the media experiment. Students can be encouraged to use a medium brought from home. Seeds such as corn or beans are satisfactory.

c) Cutting stock and materials such as rooting hormones, fertilizers, and plant containers for propagation must necessarily be obtained ahead of time.

d) Somewhat shrubby plant material such as fuchsia, willow, or English ivy usually prove to be more responsive to rooting hormone treatment than easily rooted species.

e) The activities suggested for this unit can easily be integrated with other units in the course. This approach will allow for plant growth experiments to develop over a longer period of time.

Optional Unit 4: Animals As Food Converters Time: 16 h

Heterotrophs exist in a variety of sizes and forms. Energy flows through food chains from one organism to another. The wild and domestic animals which are part of these food chains are the prime producers of protein and related meat products which are used by humans. In this unit the general behaviour of various food-producing organisms will be considered.

This unit may be divided into topics such as the following:

- Animals in energy pyramids
- Value of animals to people
- Animal digestive systems
- Energy conversion rates
- Effects of feed on growth
- Diseases from malnutrition

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the role that animals play in food chains;

b) a curiosity as to how animals may be properly nourished to produce products for society (4a);

c) an appreciation for the dependence of human life-style upon animals and their products (4b).

Skills. Students will have the opportunity to develop skill in:

a) estimating dietary intake required for common pets and/or food-producing animals such as domestic farm animals, and selected wild animals (2d);

b) observing the alimentary canals of selected organisms, for example, fish, bird, chicken, pig, or cow (2b);

c) observing and describing feed sources for food-producing animals (2d);

d) identifying various wild and domesticated animals;

e) grouping animals according to their nutritional requirements and product use (2c).

Knowledge. Students will be expected to:

a) describe a typical energy pyramid which includes animals that are used for human consumption and describe the significance of the position of animals in the pyramid (2a);

b) describe the feed requirements of domestic animals raised for commercial production of food products (2c);

c) describe the basic structure and function of the digestive system in selected animals (2b);

d) relate the digestive system of selected animals to the type of food consumed (2b);

e) compare the dietary requirements of a pet animal, a domestic farm animal, a fish, and a wild animal (2c);

f) compare the energy conversion rates of at least three different domestic animals that are used for food (2e);

g) identify the relationship between quality of food and growth rate in a domestic animal;

h) list one or two diseases found in pet or farm animals that are caused by malnutrition, and relate these diseases to diet planning (2f);

i) describe the reasons for using hormones implants and additives to feed rations.

2. Student Activities

Students are to:

*a) illustrate typical food webs in a diagram to show the relationship of common animals to their food sources;

*b) compare the structure and function of digestive systems of selected animals and relate this to their diet;

*c) compare the ingredients in common feed mixtures used for selected animals by examining the labels on the food packages;

d) prepare a feed ration based on an animal's nutritional requirements and feed the animal for a period of time to observe growth;

e) compare efficiency of body mass gain ratings for selected breeds of animals (e.g., Charolais cattle, Landrace pigs, poultry capons, Hereford steers);

f) write a report on nutritional disorders found in wild and/or domestic animals (e.g., milk fever in cows, rhinitis in swine, scurvy).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Proper protein-energy mixtures along with mineral additives in dairy rations have maximized milk production per cow while maintaining animal health.

b) Modern prepared feed mixtures contain natural grains, (oats, wheat, barley) soybean protein, minerals, and vitamins.

c) Rapid rates of gain can be achieved by hormone implants and additives to feed rations.

4. Societal Implications

a) The development of new feed-source supplements has increased the variety of feeds for pets and food-producing organisms.

b) In many parts of the world people cannot afford the cost of meat products.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) illustrations of a typical food web;

b) comparisons of the digestive systems of several animals;

c) comparisons of the ingredients in comon feed mixtures.

6. Safety Considerations

The safety considerations for this unit will depend on the scope of the selected activities.

7. Possible Extensions

Some students might:

a) visit a local animal shelter, co-op feed store, or dairy farm to observe the feeds which are available;

b) attempt to prepare a feed ration for a particular animal from basic raw materials.

8. Some Teaching Suggestions

a) The animals selected for study in this unit should be appropriate to the location of the school and the interest of the students. This unit can focus on an agricultural stituation or on the animals found in a natural ecosystem.

b) Labels from various kinds of feed bags should be collected prior to beginning the unit.

Optional Unit 5: Microbiology

Time: 16 h

The nature of the growth and reproductive capacity of many microorganisms makes them of great economic, social, and medical importance. The fundamental rules of personal, public, and domestic hygiene rest on an understanding of the characteristics of these organisms. Also microorganisms play a key role in the biosphere as decomposers of dead material.

This unit may be divided into topics such as the following:

- Role of microorganisms in ecosystems
- Types of microorganisms
- Culture techniques
- Distribution of bacteria
- Growing conditions for bacteria
- Structure of microorganisms
- Harmful microorganisms
- Control of bacteria
- Industrial and commercial uses of microorganisms

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the significance of microorganisms in maintaining matter cycles in the environment (2a, 3c, 3d);

b) respect for the potential for diseases caused by some microorganisms (3a, 3b, 4a-4c);

c) a commitment to personal and public sanitation (3b, 4a, 4d);

d) an appreciation of the diversity and number of microorganisms (2b).

Skills. Students will have the opportunity to develop skill in:

a) using a microscope to identify microorganisms and examine their structure (2b);
b) preparing diagrams to record the structure of microorganisms (2b).
c) culturing bacteria safely (2c, 2d);
d) using bacteria culture techniques to make population estimates of bacteria from different sources, such as air, water, and soil (2c);
e) designing experiments to determine the growth requirements of bacteria (2d).

Knowledge. Students will be expected to:

a) describe the role of microorganisms in ecosystems including in food chains, as decomposers in matter cycles, and in the nitrogen cycle (2a);
b) identify several different types of microorganisms, such as bacteria, fungi, algae, protozoa, and viruses (2b);
c) describe the techniques required for the safe culture of bacteria;
d) describe the distribution and frequency of bacteria in soil, air, water, and living organisms (2c);
e) explain the effect of various environmental conditions on the growth of bacteria, including light intensity, temperature, oxygen concentration, water availability, and nutrient availability (2d);

f) describe the cellular structure and organization of several microorganisms, including bacteria, fungi, algae, protozoa, and viruses;

g) state the harmful effects of some microorganisms, such as diseases in man, food spoilage, crop diseases, and water contamination;

h) describe the beneficial use of microorganisms in industrial-commercial processes such as in the production of antibiotics, wine, ensilage, yogart, cheeses, vinegar, and in the processes of tanning, and sewage treatment;

i) describe methods of controlling or inhibiting the growth of bacteria, including the use of drugs and antibiotics in diseases, chemicals (chlorine) in water treatment, dehydration, freezing, canning and pasturization of foods, and fungicides to control some crop diseases (2d, 2e).

2. Student Activities

Students are to:

a) investigate the effects of different soil types on the decomposition of a small piece of organic matter (paper) buried in a sample of each type of soil;

*b) use a microscope to observe and identify different types of microorganisms, such as bacteria, fungi, algae, protozoa, using such criteria as shape, structure, and organization (8b);

*c) culture bacteria from samples of fertile soil, pond water, and air and estimate the population of bacteria in each source (6a-6d, 8a);

d) conduct experiments to determine the effect on the growth of bacteria of factors such as variations in temperature, variations in light intensity, variations in nutrients, and the presence and absence of water (6a-6d);

e) use antibiotic discs placed on pour cultures of bacteria to determine the effect of different antibiotics on the growth of bacteria (6a-6d).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) A knowledge of microbiology provides the basis for the treatment of some diseases.

b) The preservation of food and the treatment of drinking water are based on our knowledge of the growing conditions for microorganisms.

c) Sewage treatment in urban sewage treatment plants and in rural septic tanks utilizes microorganisms to decompose organic wastes.

d) Fertile agricultural soils are maintained by adding organic matter which is decomposed by microorganisms to form humus.

e) Some commercial products such as wine, cheese, and antibiotics require the use of microorganisms.

f) Microorganisms have been used in genetic engineering experiments to produce useful products (e.g., insulin).

4. Societal Implications

a) A knowledge of bacterial control and personal hygiene may help in disease prevention.

b) Bacteria can mutate to become resistant to specific antibiotics making them difficult to control.

c) New antibiotics are constantly being discovered and tested. Some of these antibiotics are produced by bacteria discovered in soil.

d) Water supplies can be contaminated by bacteria in run-off from farms and from poor sewage treatment facilities.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) ability to design and carry out an experiment to determine the growth requirements of bacteria;

b) diagrams showing the structure of microorganisms.

6. Safety Considerations

a) Pathogenic bacteria should not be intentionally cultured.

b) Cultures should be inoculated with bacteria from sources where pathogenic bacteria are unlikely to occur.

c) Petri dishes containing cultures of microorganisms should be taped shut after inoculation and should remain sealed until disposal.

d) All bacteria cultures should be autoclaved or heated in a pressure cooker before disposal.

e) Pure cultures of non-pathogenic bacteria are available from biological supply companies.

f) Prepared, stained slides of bacteria which are available from biological supply companies should be used for microscope work.

7. Possible Extensions

Some students might:

a) visit a sewage or water treatment plant;

b) investigate the effect of ultra violet light on the growth of microorganisms;

c) use the disc technique to investigate the antiseptic effect of various non-prescription materials, such as tooth pastes, mouth washes, and disinfectants on the growth of microorganisms.

8. Some Teaching Suggestions

a) The bacterial populations in water can be compared in samples from several sources, such as a lake, river, marsh, ditch, and the tap.

b) Staining bacteria for microscopic examination can be a time consuming activity. Unstained bacteria are virtually impossible to see. Prepared, stained slides are available from biological supply companies.

c) Students can prepare nutrient agar in Petri dishes and sterilize them in an autoclave (pressure cooker). The Petri dishes should be incubated upside down at room temperature.

Optional Unit 6: Forestry Time: 16 h

Trees, by their size, are the most noticeable organisms in our ecosystems. Where they occur they are usually the dominant or major modifying organism of that ecosystem. Humans are becoming more cognizant of the need to evaluate the role of trees, not simply as providers of wood, pulp, and other products to society, but also as major contributors to the quality of our environment.

This unit may be divided into topics such as the following:

- Values of trees
- Tree age determinations and history
- Basic anatomy and physiology
- Reproduction, improvement, and regeneration methods
- Tree measurements and timber estimating
- Culture and management practices
- Forest succession
- Tree identification

1. Objectives

Attitudes: Students will be encouraged to develop:

a) an appreciation for the importance of the roles of trees in our ecosystems (3g, 4c);

b) a concern for land use projects that destroy valuable trees;

c) an appreciation that trees are a renewable resource requiring careful management practices (3c);

e) an appreciation for the benefits to humans of trees both materially and aesthetically (3a, 3d, 3g).

Skills: Students will have the opportunity to develop skill in:

a) estimating the age of tree stems from annular rings (2a);

b) classifying tree types, organs, stem tissues and reproductive parts of trees (2a);

c) measuring trees in height and diameter (2e);

d) calculating the quantity of harvestable lumber in a tree and/or a forested area (2e);

e) manipulating tree measuring equipment such as calipers, increment borers, Biltmore sticks, hypsometers (2e);

f) analysing and graphing the effect of trees on some environmental condition such as precipitation, light, and wind (2g);

g) identifying tree species by their characteristic leaves or stems (2h);

h) classifying organisms from a sample of forest duff (2f);

i) vegetatively propagating a tree such as willow or poplar from cuttings (2d).

Knowledge: Students will be expected to:

a) describe uses and products derived from trees;

b) interpret the age and past history of a tree from trunk cross-sections (2a);

c) list and label the major tree parts and the main stem tissues;

d) describe the growth areas in trees including root and stem cambium, root and branch tips, and axillary or lateral buds (2b);

e) classify several hardwood trees as to being monoecious, dioecious, or possessing perfect flowers;

f) explain the development of spores in the male and female cones of gymosperms, the disperal of male spores, fertilization, and the development of seeds in the female cones;

g) state the usual methods of propagation of cultivated and forest trees both naturally and artificially (2d);

h) explain methods such as selection and hybridization for improving native conifers;

i) describe practices of tending trees such as clearing, pruning, thinning, improvement cuttings, clipping, fertilizing, controlling pests and fire, and control of competition, and state their benefits;

j) compare the major methods of tree cutting (selection, clear cutting, shelterwood);

k) describe the effect of an orchard or forest pest on the cost of management and on the ecology of the orchard or forest;

l) list the general types of organisms found in each stratum of a forest ecosystem (e.g., canopy, duff);

m) describe the roles of various organisms in the forest duff;

n) describe the primary and secondary stages of forest succession;

o) describe problems associated with tree monoculture;

p) describe the various criteria used in tree identification from leaf or stem (2h).

2. Student Activities

Students are to:

*a) estimate the age and give the probable tree life history from a trunk cross-section (8b);

b) examine stem cross-sections and identify the various tissues (8b);

c) test a wood sample for lignin content using phluraglucin solution;

*d) propagate a tree such as willow or poplar vegetatively from cuttings (6b);

*e) measure tree diameters and heights and calculate the harvestable timber (8a);

*f) collect and identify several kinds of organisms from a sample of forest duff (8g);

*g) collect and graph data on the effect of a large shade tree on an environmental condition such as light, temperature, snow, or wind;

h) identify several hardwoods and softwoods by leaf or twig characteristics (8a).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Suitable tree species can be selected to plant as a windbreak in various locations.

b) The age of a tree could be estimated from a borer sample.

c) A woodlot can be harvested in such a way as to allow natural reseeding by desirable species.

d) A large tree on a property adds considerable economic value to that property.

e) The planting of trees on banks can stabilize the soil, and limit erosion.

f) Hybridization is resulting in better trees for fruit and forest production (e.g., apple, poplar).

g) Trees and shrubs can be planted to provide food and habitat for desirable birds and small animals.

4. Societal Implications

a) Many different careers are associated with the forest industry (e.g., lumber, pulp and paper).

b) Trees are a valuable natural resource which provide many useful products for human use.

c) Forestry and fruit products are important economic industries in Ontario.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) measurements of the height and diameter of trees and calculations of the quantity of harvestable lumber;

b) analyses and graphs of the effect of trees on some environmental conditions;

c) ability to identify tree species based on the stem and leaf characteristics.

6. Safety Considerations

a) Appropriate guidelines should be established and followed on any field trips to forested areas.

b) Sharp tools such as pruners and knives should be treated with caution.

7. Possible Extensions

Some students might:

a) demonstrate the destructive distillation of wood;

b) investigate the current market prices for firewood and/or timber;

c) collect, scarify, and attempt to germinate tree seeds;

d) investigte the methods used to break seed dormancy.

8. Some Teaching Suggestions

a) Although several forestry topics are considered in this unit a field trip to a forest is not essential, although helpful. Trees on school grounds, in local parks and from home properties can provide material for tree identification. Trees on the school grounds can be measured and the amount of timber determined.

b) Some materials that must be gathered or obtained prior to teaching the unit are suitable tree cross-sections for tree age and tissue studies, male and female conifer cones and other reproductive structures for tree reproduction studies, and leaf and branch samples for identification purposes.

c) Unbranched shoots of willow or poplar that are "pencil" thickness can be taken in the dormant season and cut into 15-25 cm lengths (top cut just above a node, bottom cut just beneath a node) and rooted in coarse sand or even in water.

d) Cut twigs of elder or birch can be placed in water in the dormant season and covered with plastic to stimulate production of staminate flowers and pollen for the reproduction studies.

e) Many kinds of collected tree seeds can be scarified to overcome dormancy by mixing them with sharp, moist sand and storing them in a refrigerator for 2 to 3 months.

f) The sales value of a local tree such as a black walnut may impress students as to the economic value of trees.

g) Forest duff for organism extraction needs to be recently collected.

h) A Ministry of Natural Resources officer or Conservation Authority officer can be invited to explain woodlot/forest management techniques.

i) In areas where woodlots or forested areas are accessible to classes, permission may be obtained to practise tending operations such as pruning and cleaning.

Optional Unit 7: Outdoor (Survival Skills Time: 16 h

Camping and hiking trips into the out of doors and particularly wilderness areas are popular leisure time activities. For these trips to be successful students must possess particular knowledge and skills relating to appreciating the out of doors and to appropriate safety precautions. A planned overnight excursion is an integral part of this unit. It may be possible to plan this excursion in cooperation with other departments in the school where field trips are part of the program.

This unit may be divided into topics such as the following:

- Planning a trip
- Safety and first aid
- Protecting the environment
- Food, water, and cooking
- Clothing, footwear, and sleeping gear
- Navigation
- Maintaining body temperature

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a commitment to be prepared when venturing into the wilderness (3a-3c);

b) an awareness of the sensitivity of the environment to human activity (4b);

c) a respect for the importance of food, clothing, and shelter for an outdoor excursion (3a, 3d).

Skills. Students will have the opportunity to develop skill in:

a) following appropriate safety precautions during an outdoor excursion (2a);

b) choosing and preparing food suitable for an excursion (2e);

c) building and using a safe fire for heating and cooking (2f);

d) finding and sterilizing water for drinking;

e) choosing the proper clothing for outdoor activities (2h);

f) choosing suitable equipment for outdoor activities (2a);

g) building an emergency shelter (2i);

h) choosing and packing a backpack or canoe pack (2c);

i) finding their way by means of maps, compasses, the sun, stars, and vegetation (2d);

j) observing their natural surroundings and identifying the location of specific biotic and abiotic features (2a);

Knowledge. Students will be expected to:

a) describe safety practices, methods of rescue, and first aid techniques for land, ice, and water (8a);

b) describe ways of protecting themselves from animals, insects, and poisonous plants;

c) state the amount of water needed by the body and list sources of drinking water and indicate ways of treating it to make it safe to drink;

d) describe the energy value of common foods, methods of packaging and storing food for outings, and some edible wild plants (2e);

e) describe the insulating qualities of different materials, and the design of clothing and footwear for the outdoors (2h);

f) state the causes of hypothermia and describe suitable preventative measures and treatment (2b);

g) describe the physical demands of various outdoor activities.

2. Student Activities

Students are to:

*a) participate in an outdoor camping excursion (6a-6f, 8j);

b) demonstrate various first aid procedures for common injuries (e.g., sprain, cut, insect bites, sunburn, hypothermia, artificial respiration);

c) compare the design, material, fit, and capacity of different packs;

*d) use a compass outdoors to take bearings and to follow bearings from a map (6a, 6c, 8c);

e) illustrate different methods of packaging food for transport;

f) build and start a fire and cook simple foods on it (6b, 6d, 8a);

g) compare tents of different material and design and build an emergency shelter (8a);

h) compare the design and properties of outdoor clothing and footwear;

i) make a basic survival kit (8a).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) People who are familiar with survival skills are more comfortable in the out-of-doors.

b) A knowledge of outdoor skills gives a person a better chance of surviving an emergency in the wilderness.

c) A knowledge of outdoor skills may lead to outdoor work or hobbies.

d) People who have studied outdoor equipment will be better able to choose equipment for themselves.

4. Societal Implications

a) The decrease of physical challenges and danger from everyday life makes people look for those things in the wilderness.

b) The growing popularity of wilderness activities is endangering many wilderness areas.

c) People who go camping and canoeing find that it is no longer possible to live off the land as the Indians and early settlers did.

d) The selection of suitable camping materials may reduce unnecessary pollution of the environment.

5. Evaluation of Student Achievement

At least 60 per cent of the term mark for this unit is to be based on students':

a) observations of the natural surroundings including specific biotic and abiotic features;

b) reports outlining safety precautions in the out of doors;

c) ability to demonstrate proper first-aid techniques for a simple injury.

6. Safety Considerations

a) A copy of travel plans should be left with a responsible person.

b) Saws, axes, stoves, and other outdoor equipment should be used in an approved manner.

c) A well maintained first aid kit should be taken on every excursion.

d) Fires should not be built outdoors when the fire risk of forest fires is high.

e) Students should be cautioned about poisonous plants and dangerous insects and animals that may be encountered on a field trip.

f) Students should report any allergies or health problems to the teacher prior to going on a trip.

7. Possible Extensions

Some students might:

a) make a list of food and clothing for a specific excursion;

b) investigate the environmental dangers, such as poison ivy in a specific district;

c) plan a trip based entirely on the use of a map and compass;

d) test the effectiveness of various insect repellents.

8. Some Teaching Suggestions

a) Safety should be emphasized in all activities in this unit.

b) This unit can be logically integrated with another unit in the course which requires a field trip.

c) An orienteering trail can be set up to be used for compass work.

d) Individual survival kits can be constructed for use on excursions.

e) An "Outdoors Club" can be organized to take weekend trips.

f) The "out of camp and leave no trace" philosophy should be emphasized.

g) Pemmican and bannock can be made in the laboratory.

h) Emergency shelters should be built only in an emergency. Many provincial parks have their own safety procedures and rules in cases of emergency.

i) It may be possible to combine the field trip with one planned by another department in the school. Cooperative planning should take place with other departments to investigate this possibility.

j) The area in which the field trip is to be taken should be investigated for potential hazards prior to taking the trip.

Optional Unit 8: Locally Designed Unit Time: 16 h

This unit is the same for the Grade 10 advanced-level environmental science course as optional unit 6, "Locally Designed Unit", in the Grade 10 general-level course. A different set of topics from those selected in a previous grade should, of course, be chosen for this course.

Core Unit 1: Energy Resources

Time: 16 h

Fossil fuels are non-renewable, pollute the environment when burned and are generally used with low conversion efficiencies. The use of nuclear energy is a controversial issue. Have we managed our energy resources wisely? In this unit students will consider the many energy options which are available and discuss those factors which are most pertinent to a secure energy future.

This unit may be divided into topics such as the following:

- Non-renewable energy
- Renewable energy
- Energy from waste
- Conservation and lifestyle
- Future energy strategies

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the dependence of all organisms on energy for survival;

b) a concern for the heavy reliance of the western world on non-renewable energy forms;

c) a questioning attitude towards lifestyles that involve wasteful use of energy (3e);

d) a supporting attitude towards scientific research that is aimed at increasing the efficiency of energy use;

Skills. Students will have the opportunity to develop skill in:

a) calculating energy conversion efficiencies (2b);

b) measuring the pH of water samples (2e);

c) calculating the half-life of a radioisotope (2d).

Knowledge. Students will be expected to:

a) recall sources of non-renewable and renewable energy;

b) analyse the advantages and disadvantages of various energy sources for Ontario consumers in terms of the risks and benefits associated with them;

c) explain the meaning of the terms cracking, refining, and petrochemical;

d) explain the meaning of the terms half-life, decay mode, and decay series and apply these terms to the production of nuclear energy (2d);

e) distinguish between active and passive solar heating;

f) list the relative energy content of various transportation fuels such as gasoline, propane, and methanol and discuss the factors involved in chosing the best transportation fuel for Ontario (2a);

g) describe various methods of obtaining energy from waste materials;

h) discuss the relationship between the pH of rain and its effects on the environment (2e);

i) summarize the environmental impact of each non-renewable energy source, and discuss the efficiency of each energy source from a cost perspective;

j) identify the major energy-consuming devices in the home and rank them for total consumption over a one-year period;

k) explain the use of the terms R-value and air-tight construction and relate these terms to home insulation (2h);

l) list the lifestyle habits which are energy efficient and those that are energy wasteful;

m) describe the factors that must be considered in planning future strategies for energy resource management in Canada and Ontario and discuss the risks and benefits of the various options.

2. Student Activities

Students are to:

a) design and carry out an experiment to measure the chemical potential energy of a fuel such as natural gas and compare the result with the accepted value;

*b) trace the energy conversions which are necessary in order to provide a home with electricity and given the conversion efficiency for each step, calculate the net efficiency of this energy system;

c) determine the power output of solar cells by taking readings with both an ammeter and a voltmeter and calculate the area of solar cells needed to produce ten kilowatts of power (for a home with DC appliances and independent of the local hydro utility) (8a);

*d) i) calculate the half-life for a radioisotope such as Barium 137 based on experimental data provided or collected using a Geiger-Muller tube and counter;

ii) graph given data to determine the decay curve for a radiosotope and establish a linear or exponential relationship for the graph;

iii) observe the difference between alpha, beta, and gamma tracks in a cloud chamber (6a, 6b);

*e) measure the pH of several water samples from various sources and compare them to the pH of natural rain water and attempt to account for the differences;

f) analyse data on the source and quantity of emissions of the oxides of sulphur and nitrogen in Ontario and suggest methods of reducing acid fallout;

g) devise an experiment to determine the energy content in one sheet of newspaper and extrapolate the result to indicate the energy potential of the newspapers that are thrown away in one week; determine the cost of purchasing this same amount of energy at current costs for energy;

h) i) do an R-value analysis of a home and carry out a heat loss calculation; identify ways of making the home more air-tight (8a);

ii) investigate modern construction techniques for energy-efficient homes and compare these dwellings for the ways they take advantage of passive solar heating (8a).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) New industries and jobs have grown out of the research and development for renewable energy forms.

b) Propane is now a widely available as a substitute transportation fuel for gasoline.

c) A permanent underground disposal site needs to be identified for the long-term storage of nuclear waste fuel bundles.

d) As manufacturing techniques have improved, the cost and efficiency of solar cells has fallen significantly.

e) An understanding of energy systems and conservation techniques has made it possible to save money in the home.

4. Societal Implications

a) The construction and operation of nuclear power plants continues to be a controversial issue. The capital cost, disposal of wastes, and the long-term effects of releasing low-level amounts of radioisotopes into the environment are topics in the debate.

b) Environmental degradation has increased dramatically with acid fallout. A large part of the problem has been traced to the burning of coal in smelters and generating stations.

c) The costs for environmental clean-up programs and pollution control equipment are the responsibility of everyone.

d) A large portion of Ontario's primary energy is imported. Energy self sufficiency is a long term goal for Canada.

5. Evaluation of Student Achievement

At least 40 percent of the term mark for this unit is to be based on students':

a) calculations of the half life of an isotope;

b) written assignments providing an analysis of the data on sources and quantity of the emissions of sulphur and nitrogen oxides in Ontario;

c) calculations of the net efficiency of the energy system used to provide a home with electricity.

6. Safety Considerations

a) Regulations for the labelling and storage of radioactive materials should be followed.

b) Hands should be washed after handling radioactive substances.

7. Possible Extensions

Some students might:

a) attempt to produce hydrogen gas by electrolysis using solar energy;

b) build a solar cooker to boil water or heat a hot dog;

c) design an experiment to demonstrate biogas production from hay infusions or silage;

d) conduct an oil-spill experiment to determine the most effective material for containing and absorbing oil from the water;

e) prepare a submission to the school principal on the advantages of running a paper recycling program at the school.

8. Some Teaching Suggestions

a) Computer software is available which can provide simulations or the analysis of data appropriate to different sections of the unit.

b) The trade offs that must be considered regarding sources of energy supply should be emphasized throughout this unit.

c) The benefits of energy conservation should be discussed in both economic terms and in terms of energy supplies for future generations.

d) A debate focussing on the cost/risk issues related to energy sources can add interest to this unit.

e) A nuclide chart which allows students to trace a decay series and to see the half-life of other daughter elements found in nuclear fuel bundles is a useful resource in this unit.

f) Radioactive sources should be labelled and stored in an approved manner.

Core Unit 2: An Aquatic Ecosystem Study Time: 16 h

Aquatic ecosystems contain a great diversity of life and play an important role in the maintenance of a quality environment. The study of a selected aquatic ecosystem provides the opportunity for students to consider examples of the various processes and relationships that exist among the organisms and abiotic factors of the ecosystem.

This unit may be divided into topics such as the following:

- Abiotic characteristics
- Plant populations
- Animal populations
- Microorganisms and water quality
- Interrelationships of organisms
- Influence of man
- Eutrophication

1. Objectives

Attitudes. Students will be encouraged to develop:

a) respect for the delicate balances in an aquatic ecosystem (4e);

b) an appreciation of the role of aquatic ecosystems in the environment (3a-3e);

c) concern about the need of clean water for all life (3a, 3e);

Skills. Students will have the opportunity to develop skill in:

a) observing and identifying various species of plants, animals, and microorganisms in an aquatic ecosystem (2b, 2d);
b) measuring the abiotic characteristics of an aquatic ecosystem, such as temperature, light intensity, pH, currents, and the chemical content of water samples (2a);
c) estimating the population of some aquatic species using various techniques (2c);
d) using a microscope to identify microorganisms present in water samples from an aquatic ecosystem (2b, 2d);
f) conducting both field and library research to investigate a specific organism in an aquatic ecosystem (2f).

Knowledge. Students will be expected to:

a) describe the abiotic characteristics at the water's surface, including temperature, light intensity, and air movement and describe the variation of these characteristics with time of day and location (2a);
b) describe the abiotic characteristics associated with water, including temperature, light intensity as a function of depth, currents, structure of the water body floor, nature of the water body surface, soluble substances, pH, and water hardness (2a);
c) list the major plant species found in the ecosystem and describe the habitat of these species in terms of the abiotic characteristics of that habitat (2a, 2c);

d) describe the variation of population densities with locations in the ecosystem for some plant species (2a, 2c);

e) list the major animal species found in the ecosystem and describe the habitat of each species in terms of the abiotic characteristics of that habitat (2a);

f) describe the variation of population densities with locations in the ecosystem for some animal species (2a, 2c);

g) list some of the microorganisms found in the ecosystem and describe the habitat of each species (2d);

h) explain the significance of the population levels of *Escherichia coli* bacteria in the water as an index of water quality (2c);

i) describe the role of some organisms in the ecosystem, for example, producers, consumers, top consumers, parasites, scavengers, decomposers, herbivores, and carnivores and give examples of each;

j) describe and give examples of the interrelationships that occur between the organisms in the ecosystem, for example, competition and symbiosis cycles (2e);

k) construct some possible food chains and food webs that may occur in the ecosystem (2e);

l) describe in detail one organism found in the ecosystem including how it is adapted to a particular niche in the ecosystem (2f);

m) explain how humans have influenced the ecosystem (2a);

n) describe the process of eutrophication in a natural aquatic ecosystem, and explain how human activity may accelerate this process.

2. Student Activities

Students are to:

*a) participate in a field study of an aquatic ecosystem, such as a pond, lake, stream, river, marsh or swamp in order to;
  i) measure the variations in air temperature and water temperature of the ecosystem at different periods of the day, and compare the variations that occur in each medium;
  ii) compare the light intensity at various depths of water in the ecosystem using instruments such as a Sechi disc;
  iii) test water samples from the ecosystem for pH and also for various chemicals such as oxygen, carbon dioxide, ammonia, nitrates, nitrites, and phosphates (6);

*b) use guide books or keys to identify the organisms found in the aquatic ecosystem;

*c) estimate the populations of some species of organisms using different techniques;

d) use a microscope to examine water samples taken from different regions of the aquatic ecosystem and identify the microorganisms present;

e) construct food chains and food webs using the species found in the ecosystem;

f) use field study techniques and library research techniques to prepare a detailed report on one species found in the ecosystem.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Aquatic ecosystems are used as a source of drinking water for a large proportion of the human population.

b) Aquatic ecosystems are the receptacles of the effluent of most sewage treatment plants.

c) Current research indicates that marshes may act as a natural treatment site for human sewage.

d) Large aquatic ecosystems frequently support an active fishery industry.

e) Water systems are integral parts of all ecosystems and necessary for life to exist.

4. Societal Implications

a) Humans have drained or filled some aquatic ecosystems to the detriment of the wildlife populations.

b) Dams built to provide water control and/or provide hydro electricity affect the behaviour of some fish and their reproductive cycles.

c) Untreated human wastes added to rivers and lakes cause serious damage to these aquatic ecosystems.

d) The increasing demand for water in North America is becoming an international issue.

e) Many human activities, such as salting roads in winter and fertilizing agriculture lands in summer frequently result in pollution and damage to aquatic ecosystems.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) ability to collect and interpret water analysis data;

b) ability to collect and interpret population estimates;

c) reports on the interrelationships of the organisms, and the food chains/webs found in the ecosystem;

d) written or oral reports on a selected organism from the aquatic environment.

6. Safety Considerations

a) Students should be warned that some plants found in the region of the ecosystem may be poisonous.

b) Students should be reminded that biting and stinging insects are frequently found in the area of many aquatic ecosystems.

c) Hands should be washed after handling plant or animal material.

d) Students should be reminded that the water in most aquatic ecosystems is not suitable for drinking. Rubber boots or hip waders should be worn.

e) Appropriate safety procedures for field trips should be established and followed.

7. Possible Extensions

Some students might:

a) construct a cross-sectional profile of a stream, or a depth profile of a small lake, and relate the various levels to the organisms found in the ecosystem;

b) construct a balanced aquatic ecosystem in a laboratory aquarium and describe the interrelationships that exist in the mini ecosystem;

c) measure the velocities and/or flow rate of a river or stream and relate the variations to the organisms found in the ecosystem;

d) conduct a laboratory experiment to determine the effect of physical factors such as heat, light intensity, and light direction on aquarium organisms;

e) investigate the meaning and significance of BOD (biological oxygen demand), and estimate this value in an aquatic ecosystem.

8. Some Teaching Suggestions

a) If an aquatic ecosystem is not available an alternative ecosystem such as a vacant lot or woodlot may be substituted. If this is the case the components of this unit must be modified to reflect the ecosystem chosen.

b) It should be emphasized throughout the unit that the purpose of the field study is to investigate an ecosystem not to destroy it.

c) The area to be studied should be visited in advance to determine its potential as well as to identify possible safety hazards.

d) Field studies permit students to cooperate in team projects as well as to work independently on individualized activities.

e) When organized into student groups, group leaders should be designated to be responsible for the various tasks and for the equipment.

f) If time in the field is limited, chemical tests on water can be done in the laboratory. Water samples should be collected in bottles, completely filled, and tightly capped to prevent contamination or the loss of gases by diffusion.

g) Unless careful preparations are made in advance, large living organisms such as frogs and fish should not be taken back to the laboratory. It is illegal to keep game fish in captivity.

Core Unit 3: Environmental Quality: Water Time: 18 h

Humans have long recognized the importance of water and have used fresh water in enormous volumes for many purposes. Humans, however, have also abused the water resource through waste contamination, the draining and filling of water bodies, and the altering of river flow with dams. This unit emphasizes the significance of water to the natural environment and thus to human activity, describes some human practices which contaminate water, and outlines some methods humans may adopt to protect the quality of the water resource.

This unit may be divided into topics such as the following:

- Distribution of water
- Physical properties of water
- Evaluation of water quality
- Water uses
- Water contamination
- Water treatment methods

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the importance of water in the biosphere (3a, 3c, 4a);

b) concern for the great demands that humans make on the water resource (3d);

c) respect for the need to conserve water and use it wisely (4a);

d) a questioning attitude towards the practice of using lakes and rivers as receptacles for untreated human and industrial wastes (3f, 4d).

Skills. Students will have the opportunity to develop skill in:

a) using water test kits to determine characteristics of water (2d, 2e);
b) constructing solubility curves for solids which dissolve in water (2a, 2b);
c) reporting investigations in a way that will enable others to repeat them (2a-2e);
d) controlling variables in an investigation to determine solubility of substances in water (2a, 2b).

Knowledge. Students will be expected to:

a) describe the distribution of water in the biosphere and construct a diagram to show the global water cycle;
b) state the boiling point and freezing point of pure water and explain the significance of the temperature range of pure liquid water (0°C - 100°C) for life on earth;
c) explain how the freezing point of water influences the availability of water to organisms in winter, the sealing of lakes by ice cover in winter, and the humidity in winter;
d) state the density of water at 4°C, and describe the unique variation of the density of water between 0°C and 4°C;
e) describe how the unique variation of the density of water with temperature influences lake water turn-over and mixing, and ice formation on the surface of water which permits survival of aquatic species;

f) state the different solubility characteristics of gas solutes and solid solutes (2b);

g) describe the relationship between the solubility of oxygen and carbon dioxide in water and temperature, and describe how this influences aquatic organisms (2b);

h) calculate flow rates for rivers and explain the significance of flow rates for the construction of dams used to generate hydroelectricity or to control water supply;

i) write the chemical equations for the formation of acids and bases by the reaction of water with the appropriate oxides (2c);

j) identify the factors that influence water quality. Examples can include suspended particles, pH, soluble salts, oxygen concentration, carbon dioxide concentration, ammonia concentration, and the presence of microorganisms (2d, 8d);

k) describe the significance of *Escherichia coli* as an indicator of sewage contamination of water (2e);

l) state the various uses of water in the natural environment, in the rural environment, and in the urban environment;

m) describe various types of water contamination such as sewage, surface run-off of fertilizers, acid rain from industry, mercury from pulp and paper mills, heat from nuclear generating stations, and oil spills in oceans;

n) describe the natural process of eutrophication and explain how water contamination may accelerate this process;

o) describe the treatment of drinking water as conducted in an urban water treatment plant and a small household treatment system (2e);

p) describe the treatment of sewage as conducted in an urban sewage treatment plant and in septic tanks.

2. Student Activities

Students are to:

*a) conduct an experiment to determine the solubility of a solid at different temperatures, and construct a solubility graph to compare temperature of water and mass of solute dissolved;

b) conduct an experiment to determine the effect of temperature on the solubility of a gas in water;

c) investigate the effect on pH of disolving the oxides of a non-metal (carbon) and a metal (magnesium) in water;

*d) conduct a number of tests to measure some of the factors that influence water quality. Examples can include suspended particles, pH, hardness, nitrates, nitrites, ammonia, oxygen, and carbon dioxide (8d);

e) estimate the coliform count in a sample of water using methods such as direct culture on agar plates, membrane filtration techniques, or commercial test kits (6a, 6b).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Clean, fresh water is essential for human consumption.

b) Drinking water for urban communities must be processed by water treatment plants.

c) Fresh water may be used for irrigation of agricultural crops.

d) Large volumes of water are consumed by some industries.

e) The kinetic energy of the water in some rivers has been used for the production of electricity.

f) Sewage water must be cleaned by sewage treatment plants before it is returned to water bodies.

4. Societal Implciations

a) Clean fresh water is necessary to maintain high standards of health.

b) The supply of fresh water is essential to maintain our present standard of living.

c) Lakes and rivers are used by many people for recreation.

d) Many human activities damage or pollute water bodies.

e) Acid rain from industry, automobiles, and other human activities is destroying many lakes in Ontario.

f) The export of water by provinces has been debated by public groups.

5. Evaluation of Student Achievement

At least 40 percent of the term mark for this unit is to be based on students':

a) ability to measure some of the factors that influence water quality;

b) laboratory reports.

6. Safety Considerations

a) If bacteria are cultured appropriate safety procedures should be followed.

b) Cultures of bacteria should be destroyed in an autoclave (pressure cooker) or with a strong base before disposal.

c) Hands should be washed after handling water samples.

7. Possible Extensions

Some students might:

a) measure the flow rate of a local stream and estimate the kinetic energy available in the moving water;

b) conduct a laboratory experiment to determine the effect on snails, daphnia, or other aquatic invertebrates of different concentrations of acid, heat, oil on the surface of the water, or different concentrations of decaying organic matter;

c) visit a sewage treatment plant or a water treatment plant;

d) visit a hydro electric generating station.

8. Some Teaching Suggestions

a) The unit can be integrated with core unit 2, "Aquatic Ecosystems". The physical properties of water can be studied in the context of their effect on living organisms.

b) Graphs should be used whenever they are appropriate to record and interpret data.

c) Some topics, such as eutrophication, lake water turn-over, and the water cycle lend themselves to student assignments, using the library as a resource. Cooperative planning should take place with the school librarian so that appropriate resources are available.

d) Many test kits are available from scientific supply companies for testing the various factors which affect water quality.

Core Unit 4: Environmental Quality: Air

Time: 12 h

Natural forms of air pollution have always existed. These pollutants, however, have been diluted, absorbed, decomposed and recycled by the environment. Today, with the enormous volume and variety of contaminants released into the air from human activities, an accumulation of pollutants and a poisoning of the biosphere is taking place. This unit will give students an understanding of the nature of air pollution and an opportunity to consider their role in the future maintenance of air quality.

This unit may be divided into topics such as the following:

- Characteristics of the atmosphere
- Atmospheric contaminants
- Matter cycles
- Particulate matter
- Air monitoring and pollution control

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the importance of the quality of air we breathe (3a, 3d-3f, 4b-4d);

b) concern about the long-term effects of environmental degradation (4a);

c) conviction that the efforts and lifestyle of one individual can make a difference to the overall environmental quality (3e).

Skills. Students will have the opportunity to develop skill in:

a) measuring the percent by volume of gases in a sample of classroom air (2a);

b) reading and interpreting an absorption spectrum of a gas (2b);

c) using a microscope to examine particulate fallout in air (2c).

Knowledge. Students will be expected to:

a) list natural forms of pollution in the environment;

b) list ways in which people have disturbed the natural quality of air (2b, 2c);

c) summarize the economic impact of air pollution and the cost of control measures;

d) list major layers of the atmosphere, giving the characteristics of each layer;

e) compare the percent by volume of the gaseous components making up unpolluted dry air (2a);

f) state the cause and effect of a temperature inversion;

g) describe several matter cycles involving air and show how human activities have disrupted these cycles (2b);

h) describe the role of the automobile in the formation of photochemical smog;

i) explain the meaning of the terms aerosol, dust, and mist;

j) describe the meaning of threshold limit value (TLV) and state the TLV for various pollutants;

k) explain how the human breathing system copes with low-level pollution;

l) explain the chemical reactions involved in the formation of ozone gas in the upper stratosphere and describe factors which affect the ozone layer;

m) describe the effects on humans, plants, and on various materials of long term exposure to air pollution;

n) explain the techniques available for measuring various pollutants in the air and explain how the pollution index is calculated (2c);

o) describe the methods available to industry for removing contaminants before they enter the atmosphere.

2. Student Activities

Students are to:

*a) perform experiments to measure the percent by volume of oxygen and carbon dioxide gas in a sample of classroom air;

*b) interpret an absorption spectrum for carbon dioxide gas and predict the effects of an accumulation of carbon dioxide in the stratosphere (the greenhouse effect);

c) measure particulate fallout in a variety of areas by drawing an air sample through a filter paper and finding the mass of the trapped particles;

*d) observe particulate fallout under the microscope and identify some of the components;

e) examine different air purifiers and compare effectiveness of the filtering devices.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Underground parking areas often have electronic carbon monoxide monitors which activate exhaust fans automatically.

b) The life of nylon goods, especially women's hosiery is shortened by exposure to air pollution.

c) Ozone in the atmosphere causes rubber to crack and can shorten the life of windshield wiper blades.

d) Office buildings must have adequate ventilation and filtration to ensure the good health of the tenants.

e) A direct link has been established between exposure to cigarette smoke on a regular basis and the occurrence of emphysema and lung cancer in the human body.

f) For some large industrialized cities, the government monitors air quality and publishes a daily air pollution index.

4. Societal Implications

a) Burning carbon-based fuels may lead to an increase in atmospheric carbon dioxide levels to the point where the climate could change. This would have a major impact on crop production.

b) Chronic exposure to air pollution is detrimental to human health, plants, and other materials.

c) Governments establish regulations to protect plants, animals, people, and property from excessive air pollution.

d) The installation of pollution control equipment on smelters and coal generating stations is expensive. Everyone must accept some of the responsibility for these costs;

e) The over insulation of homes may cause health problems by reducing the amount of fresh air that enters the house.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) laboratory reports describing the determination of the percentage by volume of gases in air;
b) ability to read and interpret the absorption spectrum of a gas.

6. Safety Considerations

Appropriate laboratory procedures should be followed for the activities which are selected.

7. Possible Extensions

Some students might:

a) demonstrate a temperature inversion;
b) measure carbon monoxide levels in various air samples using gas sampling tubes;
c) produce sulphur dioxide experimentally and expose young seedlings and other materials to this pollutant in a growth chamber;
d) obtain and analyse data on an air pollution index. Determine the factors which affect its level such as weather, and day of the week;
e) conduct a library research project on the history and success of pollution control equipment in automobiles.

8. Some Teaching Suggestions

a) Pollutants which are significant locally should be discussed.
b) A representative from the regional lung association can be invited to demonstrate the carbon monoxide level in the lungs

(and bloodstream) of non-smokers and smokers.

c) A field trip to the Ministry of Environment laboratories can be arranged. The equipment which measures air pollutants in parts per million, or even parts per trillion can be observed.

d) Guest speakers can be invited to discuss both sides of the air pollution issue.

e) A class debate on smoking in public places versus individual rights can be arranged. The issue of second hand smoke can also be discussed.

f) In this unit it should be emphasized that the individual can make a change in local air quality by adopting a personal life-style consistent with preserving the environment and by participating as a responsible citizen in the environmental issues that need the attention of society.

Optional Unit 1: Applied Genetics   Time: 16 h

Humans meet many needs through the management of plants and animals. Livestock, forests, agricultural crops, and sporting animals are managed in such a way as to produce a desirable product. Through the application of the principles of genetics undesirable traits can be reduced and favourable traits can be increased. This unit considers plant and animal breeding principles that make such advances possible.

This unit may be divided into topics such as the following:

- Basic genetics
- Animal breeding
- Plant breeding
- Selection of desirable traits

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the patience required to bring about plant and animal improvement by the application of the principles of genetics;

b) a questioning attitude towards the results of genetic research that is carried out in an effort to "improve" plants and animals (4c, 4d).

Skills. Students will have the opportunity to develop skill in:

a) identifying desirable traits in selected organisms (2d, 2f);

b) predicting genotypes and phenotypes for selected organisms (2b);

c) calculating the probability of inheriting certain traits (2b, 2d);

d) interpreting data related to the inheritance of selected traits (2c, 2h).

Knowledge. Students will be expected to:

a) distinguish between the role of heredity and the environment in influencing the characteristics of an organism (2b-2d);

b) identify genotypes and phenotypes for selected morphological traits (2b, 2c);

c) explain how genes may be transferred or inherited including the role of meiosis in this process (2a);

d) define or correctly use the terms: chromosome, recessiveness, dominance, progeny, probability, gene, sire, dam (2c);

e) explain the importance of genetic dominance, gene pool, hybrids, pedigree, and mutation to a breeding program (2b-2d, 2h);

f) describe natural and artificial breeding methods in selected animals including natural and artificial insemination, and management methods;

g) explain the meaning of the terms pollination and in-line breeding;

h) describe the meaning of the term sex as it applies to plants;

i) list methods used to select and propagate desirable plant species;

j) identify inherited characteristics in selected organisms (2b, 2c);

k) describe new genetic or breeding techniques such as ova transplants, recombinant DNA, and cloning;

l) list one or two examples of improvement in the quality of food that has occurred through applied genetics in plant and animal husbandry.

2. Student Activities

Students are to:

a) observe prepared slides of selected organisms to examine changes in the chromosomes during mitosis and meiosis (8a, 8d);

*b) analyse the data from test crosses of selected organisms such as garden pea, corn, or guinea pigs, and identify recessive and dominant genes and calculate the probability of inheriting different traits.

c) observe records for domestic animals, such as dairy cattle, dogs, cats, horses, swine, or poultry, and prepare tables for a breeding program including items such as gestation period, heat period, breeding frequency, and lactation;

d) observe mutations in plants grown from irradiated seed;

e) observe pollen cells and ova cells from cereal plants that have been treated with the chemical colchicine to demonstrate chromosome doubling;

f) graph data to show variation in a number of species (e.g. coleoptile length in oat seedlings, mass and height of students);

*g) observe a pedigree and describe how the selection of the parents has improved characteristics (e.g., butterfat content in milk, meat daily rate of gain, body contour, coleoptile length in oat seedlings);

h) compare tall and dwarf pea seedlings under treatment by gibberellic acid (8c).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

   a) Pedigrees are useful when considering the purchase of an animal.
   b) Genetic principles are used to breed selected plants and animals for agricultural, sporting, or domestic purposes.
   c) Dairy cattle which produce large volumes of milk are the result of successful breeding programs.
   d) The yield of wheat, oats, barley, and corn has improved by using seeds from the most productive plants.
   e) Horses, dogs, and cats are bred for a variety of traits such as size, disposition, speed, coat, and shape.
   f) Varieties of wheat have been bred to improve food-production in under-developed countries.

4. Societal Implciations

   a) By selective breeding, plant geneticists have been able to increase the supply of food for the human population.
   b) Many new crop varieties have little resistance to some pests. Consequently pesticides must be used for these plants.
   c) Many of our domestic animals are so highly bred that they have lost the ability to survive in the wild. Domestication and selective breeding has created a dependency on humans for assistance.

d) For large-scale mechanical harvesting, new varieties of fruit and vegetables have been developed. Sometimes some of the desirablecharacteristics such as taste may be sacrificed during this process.

e) With the use of new grain varieties, older varieties may become extinct or in short supply in the gene pool.

f) The rate of gain of beef cattle varies from one breed to another.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) laboratory exercises and reports;

b) projects, assignments and notes.

6. Safety Considerations

Plant and animal materials should be selected that are unlikely to cause student allergies.

7. Possible Extensions

Some students might:

a) grow seeds of garden flowers such as petunia, coleus, snapdragons, and pansies from the flowers collected in the home garden. Predict the seedling characteristics. Cross-pollinate some and observe the flower results;

b) compare flour made from a variety of grains (e.g., spring wheat, winter wheat, triticales, and rye). Compare the texture when mixed with water;

c) grow plants such as oats, under several environmental conditions to observe reactions to light, temperature, water, and fertilizer;

d) study pedigrees of dogs, cats, cattle, swine, poultry, or horses to investigate changes that have taken place.

8. Some Teaching Suggestions

a) Concepts relating to mitosis and meiosis should be reviewed.

b) Pedigrees are useful for studying genetics used in the mating system.

c) Gibberellic acid should be placed upon pea seedlings at about three weeks after germination.

d) It may be possible to obtain specimens of frozen bull semen from a local breeder's association.

e) Listings of cattle from breeding associations and lists of plants in seed order catalogues provide a great deal of useful information.

Optional Unit 2: Environmental Health Hazards   Time: 16 h

Recent history shows that people have been exposed to increasing amounts of chemicals, radiation, and noise, both in the work place and at home. Often people are unfamiliar with the environmental hazard present in their daily lives and are often unaware of the health risks involved. This unit will give students an introduction to the range of environmental hazards they may face in their lifetime, the possible response of their own body to these hazards, and modern strategies for preventing illness and disease related to these hazards.

This unit may be divided into topics such as the following:

- Chemical pollutants
- Radiation
- Noise pollutants
- Hazards in the home
- Control and prevention strategies

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an awareness of environmental hazards that may influence the quality of their lives;

b) a commitment to read and heed warning labels indicating hazardous chemicals (2f);

c) a respect for the limits within which their own bodies can tolerate environmental hazards (4a);

d) a commitment to share some of the responsibility for minimizing health risks on the job (4a).

Skills. Students will have the opportunity to develop skill in:

a) identifying potentially dangerous situations when hazardous chemicals are being handled (2a);
b) measuring the intensity of noise using a sound level meter (2e).
c) using the resources of the library resource centre to gather information on one specific environmental hazard (2f).

Knowledge. Students will be expected to:

a) explain the meaning of the terms threshold limit value (TLV) and carcinogenic and state the TLV for various chemicals (2f);
b) match the most hazardous chemicals with the occupations in which they are frequently encountered (2g);
c) describe the human breathing system and its defence mechanisms for airborne contaminants;
d) describe the nature of lung cancer and suggest its possible causes;
e) state the characteristics of alpha, beta and gamma radiation (2c);
f) explain the meaning of the terms ionization, mutation, half-thickness, and dose-response relationship as they relate to radiation (2c);
g) list sources of radiation to which we are exposed over a lifetime and rank these sources in terms of level of exposure for an average person for a year (2c);

i) describe the anatomy and function of the human ear and indicate where it is susceptible to damage (2e);

j) match various human activities to their known decibel level (2e);

k) state the known physiological problems which often appear for various environmental hazards and rank these for severity of impact on the quality of life of the individual (2g);

l) list environmental hazards that occur in the home (2f);

m) summarize methods used to control various hazardous materials, including legislation and outline possible future strategies for the prevention of disease in the workplace (2a, 2g).

2. Student Activities

Students are to:

*a) analyse various diagrams or photographs showing the handling of hazardous chemicals and identify one or more safety techniques which are or should be depicted;

b) demonstrate a technique for isolating an unwanted substance by precipitation (e.g., reaction of barium chloride with sodium sulphate);

c) set up a cloud chamber to observe alpha, beta, and gamma radiation and record the differences according to width and length of track;

d) use a nuclear rate meter to measure the half-thickness of a radioactive source using sheets of aluminum foil or thin metal plates (6b, 8d, 8f);

*e) use an audio generator to produce a full range of sound frequencies to determine the hearing range of the human ear and use a sound level meter to measure and record noise levels of various human activities inside and outside the school;

*f) compile a list of chemicals used at home which might pose a health risk. Examine the labels and record the generic name, concentration, and recommended dose. Investigate the TLV and physiological response to these chemicals and consider how these chemicals are used, stored, and disposed (8b);

g) examine a particular location such as an office or workplace over a period of one week and list the environmental hazards that are present and outline ways in which these hazards may be eliminated or minimized (8e).

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Many restaurants now have areas designated for non-smokers.

b) Asbestos ceiling tiles are being replaced in buildings as a precautionary measure.

c) Restrictions are in place for the sale of model airplane glue and contact cement.

d) Toxic chemicals such as benzene and carbon tetrachloride now have very limited use.

e) Lead aprons are provided to people having X-rays so that their internal organs are shielded from scattered radiation.

f) Radium is removed from waste water at Elliot Lake using precipitation methods.

4. Societal Implications

a) Employers must provide adequate protection for workers exposed to contaminants. Many claims are being made by employees who have suffered a job-related disease because these forms of protection were not provided in the past.

b) The testing of nuclear weapons has released Strontium 90, among other radioisotopes, into the atmosphere. These isotopes are now incorporated in food chains world-wide.

c) Radioactive tailings used as land fill are responsible for the abnormally high levels of radon gas in homes and schools which were built on these sites.

d) The disposal of toxic wastes has been poorly regulated in the past. Innocent people have experienced illness, disease, and possible genetic damage from poisons seeping into the soil and ground water where they live.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) laboratory notes;

b) written assignments describing safe techniques for handling hazardous chemicals;

c) ability to use a sound meter to measure sound intensity.

6. Safety Considerations

a) The use of toxic chemicals, even in demonstrations, should be avoided.

b) A pre-laboratory discussion on the safe methods of handling any radioactive material should be held.

7. Possible Extensions

Some students might:

a) prepare a case study to share with the class on a current event involving hazardous substances (e.g., the Love Canal or urea formaldehyde foam insulation);

b) germinate and plant seeds which have previously been irradiated with various doses of Cobalt 60 to analyse the mutagenic effect of ionizing radiation;

c) prepare a report on the beneficial uses of radioisotopes in society;

d) examine noise barriers used on highways in an area and use a sound level meter to determine which type is most effective;

e) dissect an old car muffler or an ear protector to observe its method of diffusing noise.

8. Some Teaching Suggestions

a) It is helpful to begin the unit with two or three case studies which give a historical perspective. A good example would be the coal miner's disease of "black lung" where the ambivalence of the miners is clear. They know the coal dust is killing them, but they desperately need the job. Other case studies include "farmer's lung" and asbestosis.

b) An environmental hazard which is often overlooked is exposure to viruses, bacteria, and moulds which breed in humidifiers, air conditioners, and refrigerator drip pans.

c) The implications of large tobacco companies sponsoring athletic events can be discussed.

d) According to the Nuclear Control Board guidelines, the average Canadian can safely receive up to 500 mrem/a. The limit for an employee of a nuclear power plant is 5000 mrem/a. Students can discuss why this double standard exists.

e) Various locations such as the school as a work place, the classroom, gym, and cafeteria can be examined for environmental hazards.

f) Regulations from the Atomic Energy Control Board in Ottawa for the use and storage of radioactive materials must be followed.

g) A local dentist can be asked to expose seeds to X-ray radiation.

Optional Unit 3: Soils: An Essential Resource   Time: 16 h

The successful management of our soil resources is necessary for the long term production of food and fibre. In this unit students explore the capabilities of soils for crop production, and then investigate the methods of maintaining soil fertility, limiting erosion, and preventing soil contaminations. Recognizing the value of this essential resource can contribute to wise decision making as to land use in the future.

This unit may be divided into topics such as the following:

- Land use capabilities
- Soil profiles
- Maintenance of soil fertility
- Maintenance of soil structure
- Chemical pollutants

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that soils are a basic component of our food and fibre producing ecosystems (4b);

b) an appreciation that an increased knowledge about soils should aid in better decision making regarding land use decisions;

c) critical-mindedness towards many land use decisions that affect the quality and quantity of soil resources (3c, 3e, 4c, 4e);

d) respect for the fact that the maintenance of soil fertility and structure requires considerable knowledge and planning to be accomplished efficiently and economically (3c, 3d, 4d).

Skills. Students will have the opportunity to develop skill in:

a) analysing soil samples to determine physical properties such as texture and structure (2a, 2b);
b) examining various soil structures under a microscope (2b);
c) scoring and classifying land areas for capability purposes (2a);
d) measuring the mineral nutrient levels in soils (2e);
e) investigating the retention of nutrient cations by various soils (2d).

Knowledge. Students will be expected to:

a) state the factors commonly used for determining land capability classifications, and explain the nature and variations in each (2a);
b) explain the general nature and potential uses of land according to the seven land use capability classifications for agriculture (2a);
c) explain the major effects of the amount of rainfall, slope, type of vegetation, temperature, nature of the soil parent material, and time, on soil profile development;
d) differentiate amongst the types of soil colloids and the ions stored on exchange sites of these colloids (2d);
e) explain the exchange of cations between soil colloids, soil water, and the plant root hairs (2d);
f) state the usual ranges of nitrogen, phosphorous, potassium, and soil pH in the soils of Ontario (2f);
g) describe the composition of various fertilizers as to available nutrients, non-nutritive portions, and fillers;
h) determine suitable fertilizer analyses and rates of application for specific purposes (2i);

i) explain the significance of good soil structure on plant development, maintenance of good tilth, and percolation of water (2b);

j) explain the use of fertilizers, compost, manures, legume rotations, cover crops, minimum tillage, and sludge applications to maintain or improve soil fertility and structure (2i);

k) identify the major types of pollutants originating in agricultural lands (nitrates and phosphates) and explain the resulting problems in runoff and ground waters;

l) identify the major leachates from such sites as landfill sites, industrial areas, and roadsides that can be a problem to society;

m) describe and explain the proper techniques for soil sample collection (2f);

n) describe the biodegradability of some commonly used pesticides on managed lands for agriculture and forestry;

o) identify and explain several commonly used methods of soil conservation.

2. Student Activities

Students are to:

*a) classify at least one land site for agricultural purposes using the standard capability classification system;

*b) analyse soil samples to determine physical properties such as structure and texture;

c) compare the solubilities of various fertilizers;

*d) investigate the retention of iron ions from iorn (III) sulphate solution or gentian violet ions when solutions of the same concentration are passed through various media including one coarse and one fine-textured soil;

- *e) test a soil for nitrogen, phosphorus, potassium, and lime levels using a soil test kit;
- f) collect a representative soil sample and send it to a soils laboratory for analysis;
- g) demonstrate the effect of too little or too much fertilizer application on potted plants;
- h) investigate the effect of the addition of acid salts or lime on soil pH;
- i) determine the application rates for various fertilizers to satisfy certain crop requirements.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

- a) Suitable crops can be designated for land that cannot be tilled because of factors such as topography or stoniness.
- b) Knowledge of the harmful effects of soil compaction (loss of soil structure) on plant growth can influence the purchasing of lighter and more appropriate farm machinery.
- c) Proper monitoring of soil nutrient levels and fertilizing accordingly can limit pollution from runoff and leaching to our water courses.
- d) A knowledge of fertilizer compositions and the nutrient level requirements of plants is necessary in scheduling appropriate fertilizers and in determining rates of application.
- e) A knowledge of texture, structure, and drainage of various soils is important in the selection of suitable land fill and waste disposal sites.

f) The effect of acid rain on nutrient availability in many soils may be considerable, necessitating liming practices.

4. Societal Implications

a) Global loss of arable lands is a major world problem.

b) Soils must be conserved and well managed to ensure world food and fibre production.

c) Improper uses of land can result in pollution problems affecting future land use or ground water quality.

d) The economics of maintaining soil fertility and structure underlie many management practices of agriculturalists and foresters.

e) Ground water quality is a prime consideration in most world areas because of its great use for human consumption.

f) Runoff is a serious urban problem, especially because of the considerable area under concrete and asphalt, which limits infiltration by water.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) analyses of soil samples to determine physical properties;

b) classifications of land areas for capability purposes;

c) laboratory reports.

6. Safety Considerations

a) Appropriate safety procedures should be established before taking students to any sites for land judging.

b) Students with cuts or wounds should avoid contact with fertilizers.

7. Possible Extensions

Some students might:

a) study the land use capability classifications for forestry or recreation;

b) investigate the taxonomic classification system for soils based on soil profile differences;

c) conduct a library research project on the biodegradability of specific pesticides;

d) investigate the possible use of local sludge(s) as soil nutrient sources.

8. Some Teaching Suggestions

a) If students have not studied soil science in grade 10, advanced-level environmental science, an overview of such topics as soil formation, soil composition, soil texture, soil water types, plant nutrients, and soil pH is appropriate prior to beginning this unit.

b) A field trip to several representative sites for land judging can enhance the teaching of the topic of land capabilities and evaluation. A stopover of 15-20 min at each site is usually sufficient for land scoring by a class.

c) Permanent miniature soil profiles could be made to illustrate characteristic soil profiles.

d) Various soil samples are needed for testing soil texture and structure.

e) A soil capability map of the local area is often interesting to students for checking their evaluations of land-sites.

f) A field trip to a local landfill or waste disposal site can be instructional.

g) Soil fertility plots on some school grounds might be possible to demonstrate management practices.

Optional Unit 4: Fish and Wildlife Conservation Time: 16 h

Canadian wildlife form a major part of our natural ecosystems. In this unit, students will consider the value, behaviour, and conservation of this valuable natural asset. Through becoming more aware of the role performed by our wildlife, humans can appreciate the need to conserve wildlife populations.

This unit may be divided into topics such as the following:

- Canadian wildlife
- Wildlife habitats
- Behaviour of wildlife
- Population ecology
- Wildlife management and conservation

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the value of wildlife to humans (2c);

b) curiosity about the diversity of wildlife in Canada (2a);

c) a concern for the necessity of maintaining wildlife habitats for the future (3c);

d) caution and respect when animals are encountered in the wild (4b, 4d, 4e).

Skills. Students will have the opportunity to develop skill in:

a) observing various species of wildlife (2a);

b) observing factors which contribute to the destruction of a habitat (2e);

c) collecting data in the field on wildlife populations and graphing and organizing this data (2a);

e) mapping a specific habitat showing the species that are present (2a);

Knowledge. Students will be expected to:

a) identify various species of Canadian wildlife (2a, 2c);
b) list the ways in which wild animals are useful to people (2c);
c) identify the species of wildlife normally found in a selected habitat (2a);
d) identify the components of food webs (2b);
e) describe the effects of modifying a habitat for wildlife (2e);
f) describe the mating habits and territoriality of several species of wildlife (2f);
g) interpret population growth curves for selected animals;
h) explain why wildlife often has to be managed in order to survive (2e, 2g);
i) identify the principle endangered species in Canada;
j) explain the part played by various private and public agencies in attempts to manage and conserve wildlife (2g);
k) describe management and conservation methods for selected animals;

2. Student Activities

Students are to:

*a) identify and map the range of various species of animals within a specific habitat (8b, 8c);
*b) examine one or two ecosystems and draw food webs showing primary, secondary, and tertiary consumers, producers,

scavengers and decomposers;

c) compile a list of wild animals used by humans, giving details of the population density of the population and the purpose for which the animal is used (8c);

d) investigate the migratory habits of waterfowl, using habitat mapping and climatic conditions;

*e) investigate the effect on the fauna in an ecosystem of the modification of their habitat;

f) investigate the size of the food supply, living space, and territoriality for a selected species;

g) investigate how government and private agencies attempt to manage and conserve wildlife populations.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Trapping has been an important part of the Canadian economy.

b) Hunting and fishing are popular pursuits in Canada and Ontario and bring many tourists into the country.

c) Natural resource authorities are working with landowners to preserve wildlife habitats.

d) Properties can be landscaped so as to attract wildlife.

e) Hunting and fishing regulations assist in wildlife conservation.

4. Societal Implications

a) Some Canadian species are being threatened by illegal hunting.

b) Wild animals, especially bears, become troublesome when they discover that their habitat is influenced by human activity (e.g., bears at a land fill site).

c) The survival of wildlife often takes second place to such human activities as farming, residential construction, and oil exploration.

d) Wilderness parks often bring people into contact with species of wildlife rarely seen in cities.

e) Wild animals sometime carry diseases that are communicable to people.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) ability to identify various wildlife species;

b) data, collected and organized, from the study of an ecosystem.

6. Safety Considerations

Appropriate cautions should be observed when studying species on location.

7. Possible Extensions

Some students might:

a) improve the habitat of a local wild species (e.g., setting out bird feeders or nesting boxes);

b) examine the trapping industry and compare the laws, permits, types of fur-bearing animals, and methods of trapping;

c) investigate the effect of agriculture or industry on a specific species;

d) study the behaviour of a particular species such as the courting and mating habits of the spruce grouse, by direct observation in the field;

e) examine the browse line of deer in a nearby wooded area;

f) investigate the hunting of endangered species for black-market purposes (e.g., elephants for tusks, alligators for skin).

8. Some Teaching Suggestions

a) Guest speakers, such as conservation officers can add interest to the discussions in this unit.

b) A field trip can taken to a nearby conservation area to study examples of good and poor habitat management.

c) Published information from various public and private agencies such as Canadian Wildlife Services or the Federation of Ontario Naturalists is useful in this unit.

d) A visit to a nearby zoo or museum to see examples of extinct or endangered species can be worthwhile.

e) The class can debate an issue pertaining to wildlife conservation.

f) It should be emphasized that natural habitats should not be disturbed on field trips.

Optional Unit 5: Pests and Pest Control

Time: 16 h

During the past several decades, there has been a great increase in the use of chemical pesticides. This use has contributed to improvements in human health, comfort, food supply, and forest product supplies. However, the misunderstanding and misuse of pesticides has created serious environmental problems which may overshadow these benefits. This unit introduces students to some of the positive and negative features of pesticides, and provides some direction to overcoming the pesticide problem.

This unit may be divided into topics such as the following:

- Types of pests
- Need for pest control
- Investigation of a pest
- Pesticide control
- Harmful effects of pesticides
- Alternative pest control

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the importance of pest control to human food supply, health, convenience, and forest product supply (3a, 3d, 4d);

b) respect for pesticides as being poisons that pose a threat to human health (3c, 4a);

c) concern for the environmental problems caused by toxic pesticides (4a);

d) an appreciation of the need to develop non-toxic means of pest control (3a, 3b, 4b).

Skills. Students will have the opportunity to develop skill in:

a) classifying pests and pesticides (2a);

b) identifying pests and pest damage (2a, 2b);

c) observing the characteristics of a pest such as an insect or a fungus (2c);

d) inferring which features of pests make them susceptible to human control (2c, 2d).

Knowledge. Students will be expected to:

a) name different types of pests, and give examples of each. These could include weeds - wild mustard, insects -aphids, fungi - apple scab, rodents - rats, and molluscs - slugs (2a);

b) describe the harmful effects of various types of pests, such as insects as disease vectors, weeds as competition for plant crops, rodents as consumers of harvested crops, insects as parasites of live stock, insects as consumers of forest trees, and slugs as consumers of ornamental plants (2b, 8b);

c) compare monocultures with other types of culture to the susceptibility to pests;

e) identify the features of a selected pest which make it susceptible to human control;

f) classify pesticides according to pest (insecticide, fungicide, herbicide, moluscicide, rodenticide), mode of invasion of pest (contact, digestive, systemic), spectrum (broad vs selective), durability (persistent vs degradable), form (dust, wettable powder, emulsifiable concentrate, gas), and chemical structure (inorganic vs organic, or, first generation vs second generation) (2e);

g) explain how pest species develop resistance to pesticides;

h) state the safety precautions that should be taken when applying, storing, or disposing of pesticides;

i) describe the path pesticides take in food chains and food webs and explain the multiplier effect (2f);

j) explain the risk of pesticide contamination on or in food products;

k) describe some alternatives to chemical pest control, such as third generation pesticides (hormones), natural predators, natural diseases, sterile male release, diversity in forests, crop rotation, sex attractants, mechanical control, and the development and use of resistant strains of crops (8c, 8d);

l) describe an integrated pest management program for a hypothetical crop and pest (2h).

2. Student Activities

Students are to:

*a) examine and identify living or preserved examples of pest species and classify the pest species;

*b) examine samples (or projection slides) of pest damage, and suggest the possible agent causing the damage;

*c) examine cultured or preserved specimens of a pest species to investigate its life cycle and infer ways of controlling the pest;

d) dissect a pest insect, or examine a pest fungus, to determine the anatomical or morphological features of the pest;

e) examine the labels from several pesticide containers and classify the pesticides according to selected criteria and record from the label the methods of application and the safety recommendations;

f) construct food chains and food webs to trace the path of pesticides in the environment;

g) compare the susceptibility and the mode of action of a herbicide, such as 2,4-D, when applied to plants such as dandelion, corn, grass, and beans;

H design an integrated pest management program for a hypothetical crop and pest.

*See the subsection entitled "Student Activities" on page 00.

3. Applications

a) Pest identification and control is essential in order to maintain economical and high levels of food production.

b) Human diseases, carried by insect vectors, have been reduced by the use of insecticides.

c) Toxic pesticides must be stored and applied in a safe manner.

d) Monocultures are susceptible to pest damage and invariably require some form of pest control.

e) Knowledge of a pest's structure and life cycle is useful in controlling the pest.

4. Societal Implications

a) Some pesticides have caused severe damage to the environment, not only at the original use site, but also on a global basis (e.g., D.D.T.).

b) Research is necessary to discover alternatives to toxic pesticides, a process requiring considerable capital and several years of investigations.

c) Research is required to develop resistant strains of crops.

d) Without pest control, starvation and health would become major world problem.

e) Pest species frequently mutate to form strains which are resistant to pesticides.

f) The use of pesticides has created considerable controversy and some lawsuits.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) classifications of pests and pesticides;

b) ability to organize and communicate data (e.g., laboratory reports on culturing a pest species);

c) interpretations of data from pesticide containers.

6. Safety Considerations

a) The poisonous nature of pesticides to humans should be emphasized.

b) The Pesticide Act should be consulted concerning the use, storage, and disposal of pesticides. The application of pesticides on school property must be done by a licensed person.

c) The manufacturer's instructions concerning the precautions needed in handling pesticides must be followed.

d) Hands should be washed with soap and water after handling and using pesticides.

7. Possible Extensions

Some students might:

a) prepare test plots on the school grounds to test the effectiveness of one or more herbicides;

b) design an experiment to determine the effect of different concentrations of 2,4-D on a specific plant;

c) design an experiment to determine the effect of the recommended concentration of 2,4-D on a specific plant at different stages of growth;

d) prepare a fact sheet on a pest in the local district which includes information such as means of identification, life cycle, host species, predatory species, benefits of the pest, damage caused by the pest, and methods of control.

8. Some Teaching Suggestions

a) Tables are an appropriate manner for recording data collected from pesticide labels.

b) Examples of damage caused by pests should be collected at the appropriate season, and stored for future use.

c) Plants used for the testing of herbicides should be grown in advance. Seed packages indicate the length of time required for germination.

d) Both the positive and negative effects of pesticides should be considered.

e) The use of pesticides in some situations, such as public parks, ornamental gardens, and forests can be discussed.

Optional Unit 6: Plants, People and Environmental Modification

Time: 16 h

The importance of plants is generally taken for granted. Plants provide sources of food, fibre, and energy, and also are essential food producers basic to any ecosystems. In addition plants contribute to the natural beauty and aesthetic values of the environment. However, the potential of plants to improve the quality of human life has not been utilized as fully as it might. In this unit students will explore some possible uses of plants as architectural or engineering elements and as modifiers of climate and pollution.

This unit may be divided into topics such as the following:

- Engineering uses
- Architectural uses
- Climatic control
- Aesthetic uses
- Rehabilitation of quarries and waste areas
- Plant characteristics and requirements
- Planting procedures
- Maintenance of plantings

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about the diversity of plants and their multitude of possible uses;

b) concern for practices or projects that will not damage or destroy vegetation;

c) an appreciation that plants require careful husbandry in order to achieve satisfactory potential (2i);

d) an appreciation of the positive emotional effects that can be achieved by the use of plants (3g, 4a, 4d);

Skills. Students will have the opportunity to develop skill in:

a) making sketches showing general architectural and engineering uses of plants (2b, 2e, 2g);

b) testing hypotheses, such as on the use of trees to modify climate (2c);

c) measuring various environmental conditions such as light intensity with a light meter, precipitation with a rain gauge, wind velocity with an anemometer, or relative humidity with a psychometer (2c);

d) drawing a plan to scale, e.g., an energy efficient homesite (2f).

Knowledge. Students will be expected to:

a) describe the effect of plants used to produce architectural features such as walls (hedges), roofs (tree canopies) and floors (turf) (2b);

b) describe the use of plants to designate areas, provide screening or privacy, and to reveal progressively interesting views (2b);

c) describe suitable kinds and species of plants and their placements to effectively reduce glare from floodlights, headlights, pools, walls, and glass, reduce sounds of highway or train traffic, control pedestrian traffic, limit soil erosion, and improve water retention (2a, 2f);

d) explain the use of plants to provide insulation of homes and buildings from heat and cold, moderation of air temperatures, reduction of wind velocities, reduction of precipitation, direction to snow accumulations, and reduction of relative humidity (2c);

e) describe the steps usually involved in rehabilitating old quarries or waste areas including rough grading, tillage or scarification, use of overburden, stabilization of the surface to prevent erosion by grasses or legumes, the planting of trees and shrubs, and the care after planting (2d, 2f, 2g);

f) list suitable plant species and combinations for use in land reclamation projects;

g) name suitable plant material to attract particular birds and small wildlife to backyard sites;

h) describe proper planting procedures for tree, shrub, and evergeen stock;

i) describe the necessary maintenance requirements of plantings including guying, rodent control, fertilizing, pruning, watering, weed and pest control.

2. Student Activities

Students are to:

a) experiment to show some engineering uses of plants, such as in limiting soil erosion, improving soil water retention, limiting glare, reducing sound, lessening air pollution, or conditioning air by cooling (8a);

*b) make sketches showing several architectural and engineering uses of plants (8a, 8b);

*c) design an experiment and carry out the procedures to show the use of a large tree or plants in climatic control, such as the amount of precipitation penetrating the foliage, the change in wind velocity through the foliage, the changes in light intensity and temperature caused by shading of the foliage, the changes in relative humidity caused by the foliage, or the locations and amounts of snow accumulation (8a);

d) investigate the use of various plants, including legumes, on infertile media such as subsoil;

e) make sketches of groupings of trees, shrubs, and evergreens that are aesthetically pleasing to show perspective, to break the monotony of long lines, to direct the vision to points of interest, and to form a background (8b, 8c);

*f) make a plan to scale using suitable symbols and naming the plant material for a particular quarry/waste area site, parkland area, campground area, energy efficient home site, or a snow-prone farmyard (8a-8c);

g) make sketches of possible arrangements and placements of woody plant materials for a quarry or waste land area (8b);

h) design a large shrub/tree grouping, naming the appropriate plant material (8b).

3. Applications

a) A bank or slope may be planted with trees to limit soil erosion.

b) An outdoor shopping mall may be cooled by an adjacent greenbelt or by a canopy of tree foliage above pedestrian walkways.

c) Shrubs bearing berries may be planted in a backyard to attract particular songbirds.

d) A windbreak may be planted about 19 m from the windward side of a long driveway to direct snow drifting.

e) Dense-foliaged trees may be planted near the house to trap insulating air.

f) Hedges and trees may be planted strategically in parklands to direct pedestrian traffic away from environmentally sensitive areas.

g) Unsightly views of human wastes or construction storage areas may be screened by plantings of suitable species.

h) The proper placement of a shade tree on a home property may provide shade, cooler air, and air movement for a desired portion of a patio for the time of day of most probable use.

4. Societal Implications

a) Human life in urban business centres and shopping malls can be made more climatically comfortable by the wise use of trees and other plant material.

b) The proper placement of buildings and plantings can effectively reduce wind funneling and undesirable snow accumulations in certain areas.

c) Soil and water are two valuable and necessary resources that can be conserved by the reforestration of headwaters and headlands.

d) Noise is a characteristic pollutant in urban areas but one which can be greatly modified by the strategic placement of plantings.

e) Energy efficiency can be improved in home and building heating through the use of suitable plantings.

f) Air pollution control mainly requires reduction at the sources. However, existing pollutants, both gaseous and aerosol, are greatly reduced in quantity by plantings.

g) Many waste areas such as strip mining areas, tailings areas, and old quarries can be returned to useful sites such as parks and forests by the wise use of overburden and plant material.

h) Runoff of waters is a major concern in large urban areas which can be greatly reduced by decreased paving, clustering of buildings, and increased vegetation.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) sketches showing several architectural and engineering uses of plants;

b) designs of experiments to show the use of plants in climate control;

c) plans for using plants to improve a particular site.

6. Safety Considerations

Appropriate safety policies should be established for any field trips to such areas as parklands, quarries, urban centres, or malls.

7. Possible Extensions

Some students might:

a) sketch the use of plants to enhance/complement architecture, unify divergent physical elements such as different building styles, enframe scenes, soften architecture, provide backgrounds, or provide reflections/silhouettes;

b) investigate possible plant species for specific uses;

c) plant some trees or shrubs on the school grounds or as part of a community planting project.

8. Some Teaching Suggestions

a) This unit provides the opportunity to discuss the use of plants to control the environmental. Current literature is available covering the principles involved and providing suitable background information that will suggest desirable areas for elaboration or specialization.

b) Sketching and drawing plans to scale are an important facet of this unit. This ability is very useful in park, urban, and home planning.

c) Visual aids should be accumulated to illustrate some of the concepts of good design.

d) This unit can be integrated with the optional unit, "Landscape Design", and appropriate other optional units to become a course on the scientific approach to urban or park planning.

Optional Unit 7: Outdoor (Survival) Skills

Time: 16 h

This unit is the same for the Grade 12, advanced-level environmental science course as optional unit 7, "Outdoor (Survival) Skills", in the Grade 10, advanced-level environmental science course. Teachers should plan this unit so that it complements the unit in grade 10.

Optional Unit 8: Locally Designed Unit

Time: 16 h

This unit is the same for the Grade 12 advanced-level environmental science course as optional unit 4, "Locally Designed Unit", in the Grade 10 general-level environmental science course. A different set of topics from those selected in a previous grade should, of course, be selected for this course.

Appendix A

Science Courses and Their Course Codes

The secondary school guideline courses in science authorized under this document have the following course codes:

Science, Grade 9, Basic Level	SNC1B
Science, Grade 9, General Level	SNC1G
Science, Grade 9, Advanced Level	SNC1A
Science, Grade 10, Basic Level	SNC2B
Environmental Science, Grade 10, General Level	SEN2G
Science, Grade 10, General Level	SNC2G
Environmental Science, Grade 10, Advanced Level	SEN2A
Science, Grade 10, Advanced Level	SNC2A
Science, Grade 11, Basic Level	SNC3B
Applied Biology, Grade 11, General Level	SBA3G
Applied Chemistry, Grade 11, General Level	SCA3G
Environmental Science, Grade 11, General Level	SEN3G
Biology, Grade 11, Advanced Level	SBI3A
Chemistry, Grade 11, Advanced Level	SCH3A
Science, Grade 12, Basic Level	SNC4B
Applied Physics, Grade 12, General Level	SPA4G
Environmental Science, Grade 12, General Level	SEN4G
Technological Science, Grade 12, General Level	STE4G
Environmental Science, Grade 12, Advanced Level	SEN4A
Geology, Grade 12, Advanced Level	SGE4A
Physics, Grade 12, Advanced Level	SPH4A
Biology, OAC	SBI0A
Chemistry, OAC	SCH0A
Physics, OAC	SPH0A
Science in Society, OAC	SSO0A

The following general rules govern science course codes:

- All science course codes begin with an **S.**
- **SNC** identifies a course that has only the name "Science".
- Where one word other than "Science" describes the course, the first two letters of that word follow the **S** (e.g., **SBI** means "Science, Biology" or simply "Biology"; **SEN** means "Science, Environmental" or "Environmental Science").
- Where two words other than "Science" describe the course, the initial letters of those words are used (e.g., **SCA** means "Science, Chemistry Applied" or simply "Applied Chemistry").
- The fourth character in the course code, **1**, **2**, **3**, **4**, or **0**, represents Grade 9, 10, 11, 12, or an OAC respectively.
- The fifth character represents the level of difficulty: **B** for basic, **G** for general, or **A** for advanced.

For further information on course codes, refer to the *Manual for the Common Course Code* (Toronto: Ministry of Education, Ontario, 1986).

Appendix B

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